HEADQUARTERS

OGDEN AIR LOGISTICS CENTER

UNITED STATES AIR FORCE

HILL AIR FORCE BASE, UTAH 84406

PROPELLANT

SURVEILLANCE REPORT

LGM-30 A&B STAGE 1

TP-H1011

PROPELLANT LAB SECTION

MANCP REPORT

NR 388(78)

JANUARY 1978

MANCP REPORT NR 388(78)
MMEMP PROJECT M82934C-~~WL17514~~

PROPELLANT SURVEILLANCE REPORT

LGM-30 A & B STAGE I

TP-H1011

Author

JOHN A. THOMPSON, Chemist
Component & Combustion Test Unit

Engineering & Statistical Review By

JOHN K. SCAMBIA, Project Engineer
Service Engineering

EDWARD J. ERICKSON, Statistician
Data Analysis Unit

Recommended Approval By

RONALD F. LARSEN, Chief
Physical & Mechanical Test Unit

LEONIDAS A. BROWN, Chief
Component & Combustion Test Unit

Approved By

DON F. WOODS, Chief
Propellant Laboratory Section

January 1978

Industrial Products & Landing Gear Division
Directorate of Maintenance
Ogden Air Logistics Center
United States Air Force
Hill Air Force Base, Utah 84406

ABSTRACT

This report contains propellant test results from cartons of TP-H1011 bulk propellant representing LGM-30 A and B First Stage Minuteman Motors. This report is the thirteenth time that a statistical approach has been used to analyze First Stage bulk carton propellant. Testing was accomplished in accordance with MMEMP Project M82934C-WNL17514.

The purpose of testing was to determine and provide early warning of any serious degradation trends occurring in the propellant for service life predictions.

An analysis of all parameters indicates that no potential problems are expected in the propellant for at least two years past the oldest data point.

Data stored in the G085 System were plotted utilizing the IBM 360-65 Computer and CAL-COMP Plotter. The data range at any age can be found by suitable inquiry of the G085 System.

Each point on the regression plot represents the mean of all samples at that particular age. The number of specimens at each point is indicated on the sample size summary sheet accompanying each regression plot or group of regression plots.

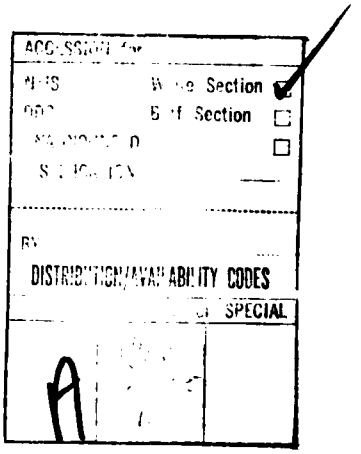


TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (CONT)

LIST OF FIGURES (CONT)

LIST OF REFERENCES

Report Nr	Title	Report Date
	LGM-30 First Stage, Wing I Test Reports	
29A	Test Report (Missile in silo)	13 Jan 64
29B	Zero Time Test Results	29 Jan 64
29C	Zero Time Test Results (Supplement 1)	30 Mar 64
29D	Zero Time Test Results (Aft Closure)	9 Jun 64
29E	Zero Time (Aft Closure Supplement 1)	24 Jun 64
29F	ATP Phase I Test Results	30 Mar 65
29G	ATP Phase I Test Results	19 Aug 65
29H	ATP Phase I Test Results	10 Sep 65
32A	Zero Time, Wings II-V Test Results	17 Mar 65
32B	Zero Time, Wings II-V Test Results (Aft Closure)	18 Mar 65
32C	ATP Phase I, Wings II-V Test Results	3 Nov 65
49	ATP Phase I, Wings II-V (First Group)	18 Mar 66
53	ATP Phase I, Wings II-V (Second Group)	22 Apr 66
55	ATP Phase I, Wings II-V (Third Group)	29 Apr 66
58	ATP Phase I, Wings II-V (Fourth Group)	6 May 66
61	ATP Phase I, Wings II-V (Fifth Group)	10 Jun 66
66	ATP Phase I, Wings II-V (Sixth Group)	22 Jul 66
76	ATP Phase II, Wing I Test Results	24 Jan 67
78	Zero Time, Wing VI Test Results	3 Feb 67
104	ATP Phase I, Wing VI (First Group	12 Oct 67
118	ATP Phase II, Wings II-V (First Group)	5 Mar 68

LIST OF REFERENCES (CONT)

Report Nr	Title	Report Date
126	ATP Phase II, Wings II-V (Second Group)	11 Apr 68
130	ATP Phase II, Wings II-V (Third Group)	3 May 68
162	ATP Phase I, Wing VI (Second Group)	30 Sep 69
176	ATP Phase II, Wing VI (First Group)	15 Apr 70
181	ATP Phase III, Wing I	7 May 70
185	ATP Phase I, Wing VI (Third Group)	22 Jun 70
195	ATP Phase III, Wings II-V (Retest)	29 Oct 70
223	Surveillance Report LGM-30 Stage I (TP-H1011)	Sep 71
239	Surveillance Report LGM-30 Stage I (TP-H1011 and TP-H1043)	Apr 72
258	Surveillance Report LGM-30 A & B Stage I (TP-H1011)	Nov 72
268	Surveillance Report LGM-30 A & B Stage I (TP-H1011)	May 73
271	Surveillance Report LGM-30 F & G Stage I Phase A Series II, (TP-H1011)	Jul 73
277	Surveillance Report LGM-30 F & G Stage I Phase A Series III, (TP-H1011)	Oct 73
280	Surveillance Report LGM-30 A & B Stage I (TP-H1011)	Nov 73
288	Propellant Surveillance Report LGM-30 A & B, Stage I, TP-H1043	Mar 74
290	Propellant Surveillance Report LGM-30 F & G, Stage I, Phase B, Series I TP-H1011	Mar 74
300	Minuteman Stage I Motor Reliability Improvement Program Surveillance	May 74

LIST OF REFERENCES (CONT)

Report Nr	Title	Report Date
302	Propellant Surveillance Report LGM-30 A & B Stage 1, TP-H1011	Nov 74
313	Stage 1 Propellant Surveillance Report, Propellant Containing Glacial Acrylic Acid	Oct 74
315	Propellant Surveillance Report LGM-30 F & G Stage 1, TP-H1011	Jan 75
316	Propellant Surveillance Report LGM-30 A & B Stage 1, TP-H1011	Feb 75
319	Propellant Surveillance Report LGM-30 Dissected Motors, Phase VI, TP-H1011	Apr 75
321	Propellant Surveillance Report LGM-30 F & G Stage 1, Phase B, Series II, TP-H1011	Apr 75
325	Propellant Surveillance Report LGM-30 A & B Stage 1, TP-H1011	Jun 75
328	Propellant Surveillance Report LGM-30 A & B Stage 1, TP-H1011	Sep 75
330	Propellant Surveillance Report LGM-30 F & G Stage 1, TP-H1011	Oct 75
335	Stage 1 Motor Reliability Improvement Program	Dec 75
337	Propellant Surveillance Report LGM-30 A & B, Stage 1, TP-H1043	Feb 76
339	Stage 1, New MAPO & ERL-510 Qualification	Mar 76
341	Propellant Surveillance Report LGM-30 Dissected Motors, Phase VII, TP-H1011	Mar 76

Report Nr	Title	Report Date
343	Propellant Surveillance Report LGM-30 A & B, Stage 1, TP-H1011	Jun 76
345	Propellant Surveillance Report LGM-30 F & G, Stage 1 Phase B, Series III, TP-H1011	Jun 76
350	Qualification of a New MAPO Source and ERL-510 Curing Agent for Minuteman, Stage 1, UF-2121 Liner	Sep 76
351	Propellant Surveillance Report LGM-30 A & B, Stage 1, TP-H1011	Sep 76
354	Minuteman Stage 1 Motor Reliability Improvement Program Surveillance	Sep 76
358	Propellant Surveillance Report LGM-30 Dissected Motors, Phase VIII, TP-H1011	Oct 76
360	Propellant Surveillance Report LGM-30 F & G, Stage 1 Phase E, Series III, TP-H1011	Nov 76
367	Propellant Surveillance Report LGM-30 A & B, Stage 1, TP-H1011	Apr 77
370	Propellant Surveillance Report LGM-30 F & G, Stage 1, Phase E, Series II, TP-H1011	May 77
377	Qualification of a New MAPO Source and ERL-510 Curing Agent for Minuteman Stage 1, UF-2121 Liner	Oct 77
379	Final RIP Report, Minuteman Stage 1 Motor Reliability Improvement Program Surveillance	Oct 77
385	Propellant Surveillance Report LGM-30 A, B, F, & G, Stage 1, TP-H1043	Dec 77

GLOSSARY OF TERMS AND ABBREVIATIONS

Aging Trend	A change in properties or performance resulting from aging of material or component
CSA	Cross Sectional Area
DB	Dogbone
Degradation	Gradual deterioration of properties or performance
E	Modulus (psi), defined as stress divided by strain along the initial linear portion of the curve.
EB	End Bonded
EGL	Effective Gage Length
em	Strain at maximum stress
er	Strain at rupture
"F" ratio	The ratio of the variance accounted for by the regression function to the random unexplained variance. The regression function having the most significant "F" ratio is used for plotting data. The ratio is also used in detecting significant changes in random variation between succeeding time points
JANNAF	Joint Army, Navy, NASA, Air Force
MANCP	Propellant Lab Section at Ogden Air Logistics Center
Ogden ALC	Ogden Air Logistics Center, Air Force Logistics Command
r or R	The Correlation Coefficient is a measure of the degree of closeness of the linear relationship between two variables
Regression Equation	The general form of the regression equation is $Y = a + bx$
Regression Line	Line representing mean test values with respect to time
S_b	Standard error of estimate of the regression coefficient

S_e or $S_{Y.X}$	Standard deviation of the data about the regression line
Sm	Maximum Stress
Sr	Stress at rupture
Standard Deviation (S_y)	Square root of variance
Strain Rate	Crosshead speed divided by the EGL
"t" test	A statistical test used to detect significant differences between a measured parameter and an expected value of the parameter (determines if regression slope differs from zero at the 95% confidence level)
Variance	The sum of squares of deviations of the test results from the mean of the series after division by one less than the total number of test results
3 Sigma Band	The area between the upper and lower 3 sigma limit. It can be expected that 99.73% of the inventory represented by the test samples would fall within this range assuming that the population is normally distributed.
90-90 Band	It can be stated with 90% confidence that 90% of the inventory represented by the test samples would fall within this range assuming that the population is normally distributed

INTRODUCTION

A. PURPOSE:

Quality assurance tests have been conducted for fourteen and one half years on First Stage LGM-30A and B Minuteman Motor Propellant blocks to evaluate the effects of aging on TP-H1011 propellant.

Statistical analysis of the tests performed, as directed by Engineering, should provide early warning if serious degradation trends occur. Annual evaluation of the propellant provide data that can be directly input into engineering reliability and service life predictions. Testing was performed in accordance with MMWRM Directive GTD-1C and GTD-1C Amendments 1 and 2.

B. BACKGROUND:

Testing was first accomplished at MANCP on LGM-30A TP-H1011 propellant blocks in 1963 and was designated Zero-Time Testing (MAGCP Report Nrs 29B, 29C and 29F). Subsequent testing was accomplished at approximately 24 month intervals (MAGCP Report Nrs 29G, 29H - Phase I; 76 - Phase II; 181 - Phase III).

LGM-30B Zero-Time testing was accomplished in 1964 with subsequent testing at intervals of 24 months (MAGCP Report Nrs 32A-Zero-Time; 32C, 49, 53, 55, 58, 61, 66 - Phase I: 118, 126, 130-Phase II; 195, 268 - Phase III).

Reports prior to MAGCP Report Nr 223(72) contained raw data using sigma relation to compare to Zero-Time variance. MANCP Report Nr 239(72) published in April of 1972 contained all the

data on LGM-30A, B, F and G in the G085 System at that time. Report Nrs 258(72), 268(73) reported LGM-30A and B data in statistical analysis by itself. This report is the eighth time that LGM-30A and B data have been reported in this manner.

Zero-Time testing was started as soon as possible after receipt of the propellant by MANCP. Data from these tests were used to establish a base line for each test to which each subsequent test data (ATP - Accelerated Test Plan) were compared in the reports listed above.

The LGM-30A and B propellant test matrix (Table 1) were used to determine the number of specimens to be taken from each propellant loaf and the specific test or tests to which these specimens were subjected. Low rate tensile and hardness specimens were taken from all LGM-30A and B blocks. Specimens for other physical and combustion tests were taken from every seventh block.

Some tests were not conducted at the earlier test periods (0-6 years) and, therefore, data are not available for inclusion in the regressions.

Table 1

Test Program

The test matrix is taken from GTD-1C, Amendment 2, and the tests, conditions, number of specimens and test methods are listed below.

Test	Conditions	Description	Per Cond
Hardness	10 Sec	Dogbone Ends	3
Low Rate Tensile	2.0 in/min	1/2" JANNAF Dogbone	3
High Rate Tensile	1750 in/min	3/4" Dogbone	3
High Rate Triaxial Tensile	600 psi, 1750 in/min	3/4" GL Rail End Bonded	1
Low Rate Biaxial Tensile	0.2 in/min	3/4" GL Rail End Bond	1
Stress Relaxation	3% & 5%	1/2" x 1/2" x 4" EB	3
Dynamic Response	70 gm ct wt	3.3" dia x .33" disc	1
Sol Gel		1/2" x 1/2"	8
VLR	2×10^{-3} in/min	1/2" JANNAF Dogbone	3
Ignitability	168 cal/cm^2 sec	.050" wafer	3
TCLE		.200" wafer	3
Pressure Time	500 psi	1/2" x 3/8" x 1"	3
Burning Rate	1000 psi	.156" x .156" x 5" Strand	3
DTA	12°C Rise/min	.040" wafer	3
DSC		.040" wafer	3
Poisson's Ratio	77°F $\pm$ 2° 15% Strain	.50" x .50" x 4"	6
Tear Energy	70°F $\pm$ 2°	0.1" x 1.18" x 3"	6
Failure Envelope		JANNAF Dogbone	3

STATISTICAL APPROACH

In order to determine aging trends for shelf/service life predictions, as directed by Service Engineering, First Stage LGM-30A and B Minuteman Motor propellant (TP-H1011) blocks have been under-going testing since 1963, statistically analyzed and reported on a regular test cycle by this laboratory.

The primary reason for performing statistical analysis on test data is for the detection of propellant changes due to aging that would affect motor reliability. Regression analysis was the method used to examine data and to aid in drawing conclusions about dependency relationships that may exist i.e., relationship between age versus test results.

In selecting the best fit model for the regression equation, six models were fitted to the data (see regression models at the end of this statistical approach). The linear model $Y = a + bX$ was found to be the best fit model for the regressions in this report 98% of the time. The model used is shown in the regression equation at the top of every regression plot and those which are not linear will also be listed and discussed in the test results section.

Individual data points from different time periods were used to establish a least squares trend line for the data. The variance about the regression line, obtained using individual values of the dependent variable, was used to compute a tolerance interval such that at the 90% confidence level 90% of the sample distribution falls within this interval. This tolerance interval was extrapolated to a maximum of 24 months into the future from age of the odest motor tested. The 't' values and the

significance of this statistic, which are reported for each regression model, give an indication of the 'statistical significance' of the slope of the trend line as compared to a line of zero slope. Data were plotted by computer. The 'y' axis is computed so that the values at one inch intervals are peculiar to the data spread of the parameter tested. Plotted data points represent means at the particular ages at which testing occurred. The number of specimens at each age point is indicated on the sample size summary sheet accompanying each regression plot or group of regression plots. Variance at each test age can be determined by consulting the G085 data storage system.

In a few cases, a small change has become apparent in data variance and regression trend lines. However, the changes are gradual and no operational problems are expected at this time.

A post cure effect (propellant stabilizing after the first year or two) has been observed on some of the early test data (pressure time, low rate biaxial tensile, high rate tensile, and high rate triaxial tensile) which tended to bias and skew the projected trend lines. To overcome this factor, two methods of analysis were performed: First, where possible, non-linear models were used that would best fit the total data (pressure time (max pressure));

second, where non-linear models did not fit the data, this early data was eliminated (Low Rate Biaxial, High Rate Tensile, and High Rate Triaxial). By compensating for this post cure biasing,a more accurate aging trend line for service life prediction is provided.

REGRESSION MODELS

Reciprocal of X	$Y = a + b\ (1/X)$
Natural log of X	$Y = a + b\ (LN\ X)$
LOG to the base 10 of X	$Y = a + b\ (LOG\ X)$
Square Root of X	$Y = a + b\ \sqrt[2]{X}$
Cube Root of X	$Y = a + b\ \sqrt[3]{X}$
Linear equation	$Y = a + bX$

TEST RESULTS

A. TENSILE:

Regressions for very low rate tensile data show a statistically significant decrease for strain at maximum stress and strain at rupture. The maximum stress regression shows a statistically significant increase with stress at rupture showing no significant change. The regression for modulus shows a statistically significant increase. However, the regression slopes that do show a statistically significant change are gradual (Figures 1 thru 5).

Low rate tensile for strains and stress at rupture show a statistically significant decrease. Maximum stress and modulus show a statistically significant increase (Figures 6 thru 10).

For low rate biaxial tensile testing, strain at maximum stress does not show a significant trend with strain at rupture showing a statistically significant decrease. Maximum stress and modulus show a statistically significant increase. There is no significant change for stress at rupture (Figures 11 thru 15).

The high rate tensile strain at maximum stress shows a statistically significant increase. Maximum stress, strain at rupture and stress at rupture all show a statistically significant decrease (Figure 16 thru 20).

For triaxial tensile testing, strain at maximum stress and strain at rupture show a statistically significant increase. Maximum stress and stress at rupture do not show a significant change. Modulus shows a statistically significant decrease (Figures 21 thru 25).

For all of the tensile tests, the regressions show trends that are

gradual and no operational problems are expected in the propellant for at least two years beyond the oldest data point.

B. STRESS RELAXATION:

Modulus at both 3% and 5% strain shows a statistically significant increase for all time periods (Figures 26 thru 33). However, the slope of the trend lines are gradual and no operational problems with the propellant are expected.

C. HARDNESS:

There is a statistically significant increase in hardness data (Figure 34). The increase in hardness correlates with the tensile testing data where the strains, in general, show a decrease and stresses and modulus show an increase.

D. DYNAMIC RESPONSE:

The storage shear modulus at 200 and 400 H_z show a statistically significant decrease while the loss tangent at 200 and 400 H_z shows a statistically significant increase (Figures 35 thru 38).

E. CONSTANT STRAIN:

Strain at rupture for constant strain does not show a significant change (Figure 39).

F. TCLE (Thermal Coefficient of Linear Expansion):

The thermal coefficient of linear expansion below and above the glass transition point shows a statistically significant increase (Figures 40 & 41).

G. SOL GEL:

The cross link density shows a statistically significant increase with a statistically significant decrease shown for percent extractables and weight swell ratio (Figures 42 thru 44).

The increasing cross link density trend correlates well with the other physical properties. The tensile testing shows an increase in maximum stress and modulus with the strain decreasing. In addition, hardness is increasing as would be expected with increased cross linking and the stress relaxation, dynamic response and constant strain also correlates with cross link density.

H. DTA (Differential Thermal Analysis):

For the DTA regressions the endotherm and first and second exotherms show a statistically significant decrease. The third exotherm and ignition temperature shows a statistically significant increase (Figures 45 thru 49). In all cases the changes are gradual and no problems are indicated for the propellant at this time.

I. PRESSURE TIME:

Maximum pressure shows a statistically significant decrease and the time to maximum pressure shows a statistically significant increase (Figures 50 and 51).

J. BURNING RATE:

The burning rate shows a statistically significant decrease (Figure 52). This correlates with the increasing time to maximum pressure.

CONCLUSIONS

This report includes LGM-30 A and B bulk propellant test results presently in the G085 System and covers the past fourteen and one half years of testing.

The test results show that under present storage conditions the physical/mechanical and combustion properties of the propellant are remaining relatively stable with age. This is indicated by the regression plots where the slope of the trend line is relatively flat or close to a line of zero slope and have not changed appreciably from the last test period.

From the statistical analyses, all tests conducted indicate that motor propellant reliability will not be affected for two years past the last data point on the regression.

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
15.0	18	96.0	29	121.0	24	147.0	3
17.0	21	97.0	34	122.0	21	152.0	6
18.0	6	98.0	41	123.0	19	153.0	24
21.0	6	99.0	33	124.0	20	154.0	12
73.0	9	100.0	34	125.0	18	155.0	9
75.0	18	101.0	42	126.0	51	156.0	2
77.0	18	102.0	34	127.0	26	158.0	3
78.0	3	103.0	49	128.0	42	160.0	6
79.0	9	104.0	20	129.0	28	162.0	6
80.0	30	105.0	39	130.0	18	163.0	6
81.0	18	106.0	28	131.0	25	164.0	3
82.0	9	107.0	28	132.0	24	165.0	3
83.0	18	108.0	44	133.0	20	166.0	3
84.0	18	109.0	19	134.0	39	168.0	6
85.0	6	110.0	26	135.0	45		
86.0	40	111.0	24	136.0	18		
87.0	27	112.0	29	137.0	39		
88.0	23	113.0	41	138.0	21		
89.0	13	114.0	15	139.0	12		
90.0	7	115.0	16	140.0	24		
91.0	36	116.0	27	141.0	33		
92.0	7	117.0	12	142.0	21		
93.0	15	118.0	33	143.0	6		
94.0	22	119.0	27	145.0	3		
95.0	22	120.0	36	146.0	3		

STAGE 1,WING 1&2 VERY LOW RATE CHS=0.002 IN/MIN MODULUS (E)

This sample size summary is applicable to figures 1 thru 5

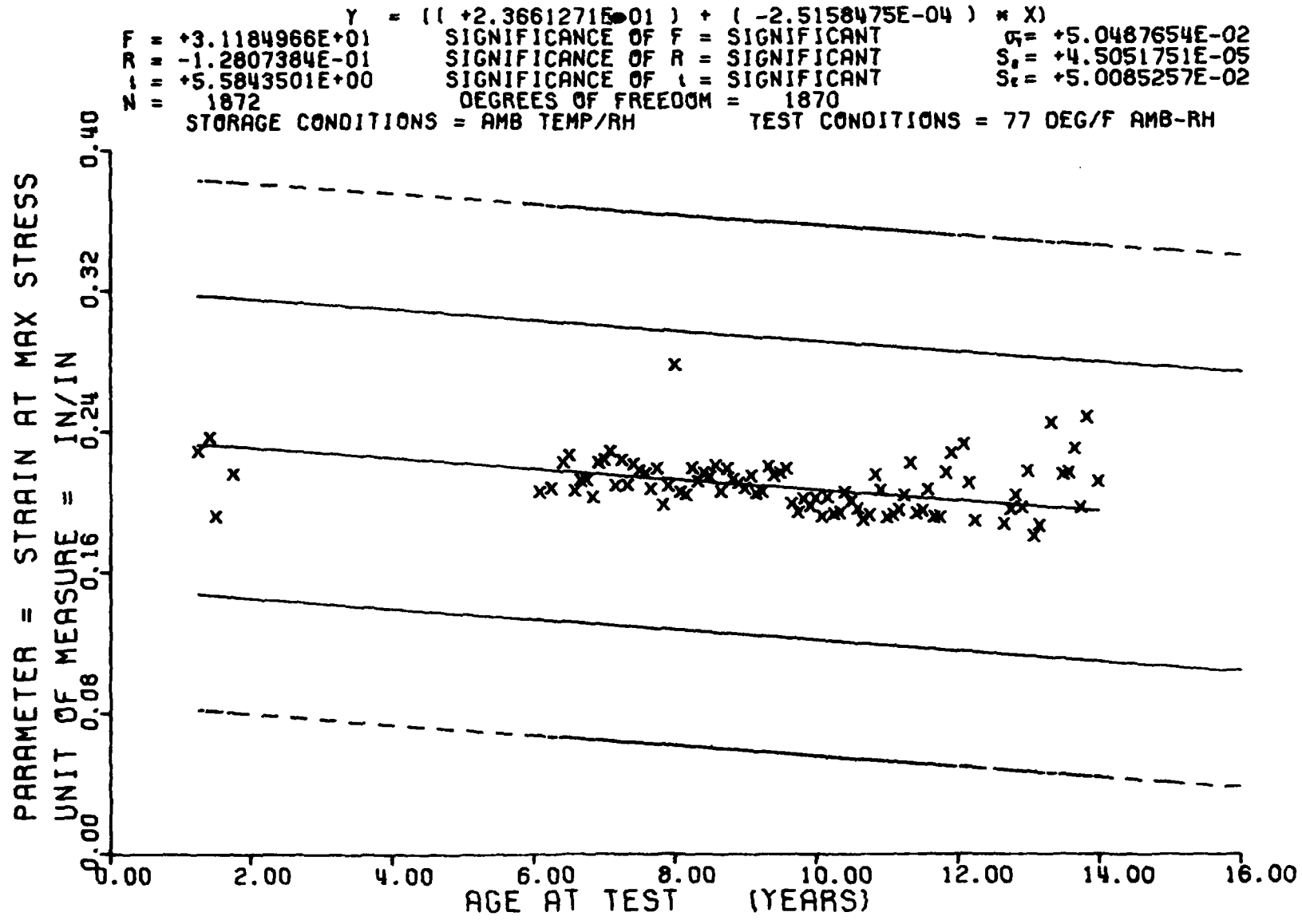

Y = ((+2.3661271E+01) + (-2.5158475E-04) * X)
F = +3.1184966E+01 SIGNIFICANCE OF F = SIGNIFICANT σr= +5.0487654E-02
R = -1.2807384E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb= +4.5051751E-05
t = +5.5843501E+00 SIGNIFICANCE OF t = SIGNIFICANT Sε= +5.0085257E-02
N = 1872 DEGREES OF FREEDOM = 1870
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = 77 DEG/F AMB-RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.00
0.08
0.16
0.24
0.32
0.40
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 VERY LOW RATE CHS=0.002 IN/MIN STRAIN AT MAX STRESS (EM)

Figure 1

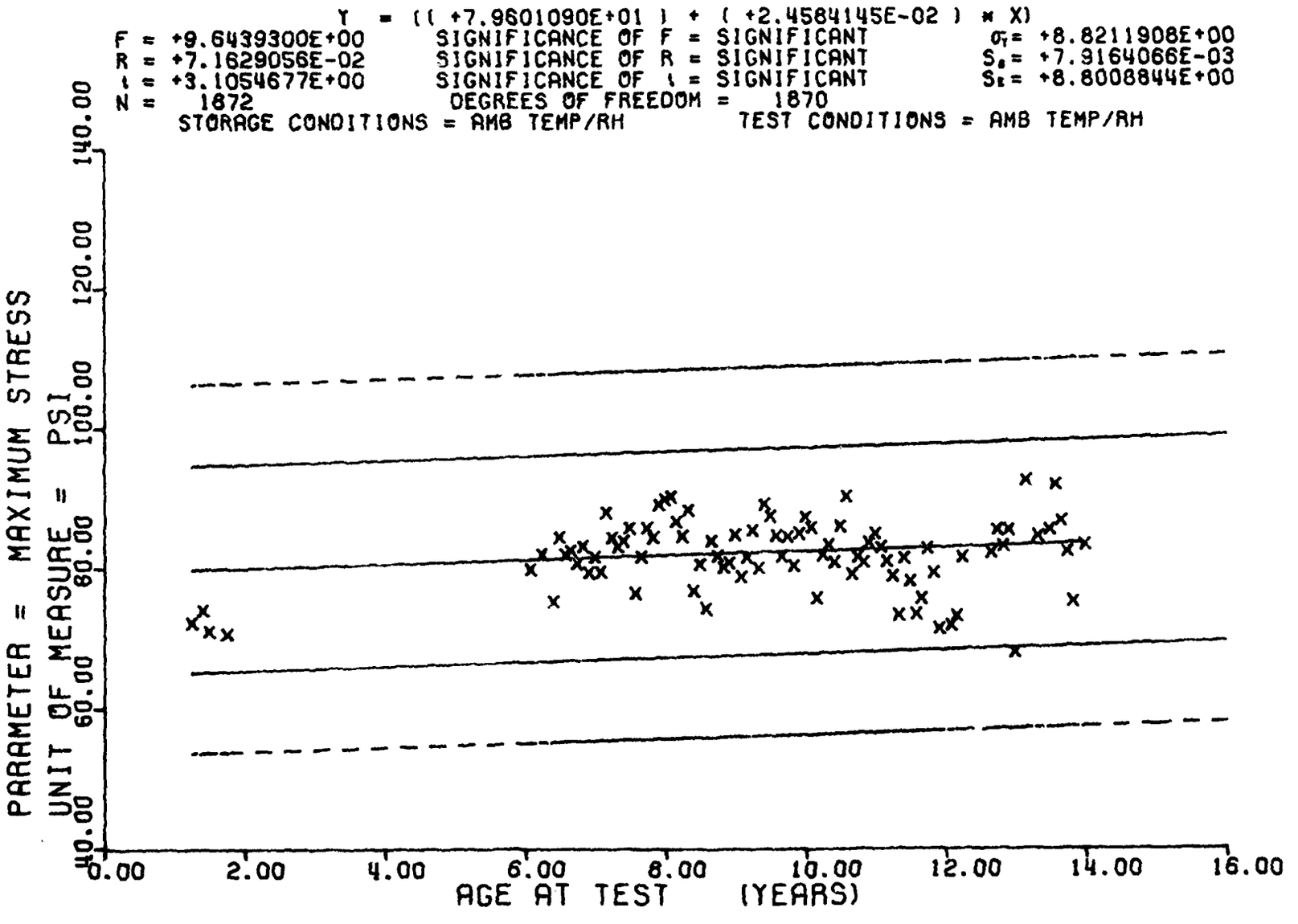

Y = ((+7.9601090E+01) + (+2.4584145E-02) * X)
F = +9.6439300E+00
SIGNIFICANCE OF F = SIGNIFICANT
σT = +8.8211908E+00
R = +7.1629056E-02
SIGNIFICANCE OF R = SIGNIFICANT
Se = +7.9164066E-03
t = +3.1054677E+00
SIGNIFICANCE OF t = SIGNIFICANT
St = +8.8008844E+00
N = 1872
DEGREES OF FREEDOM = 1870
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = AMB TEMP/RH
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
140.00
120.00
100.00
80.00
60.00
40.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 VERY LOW RATE CHS=0.002 IN/MIN MAXIMUM STRESS (SM)

Figure 2

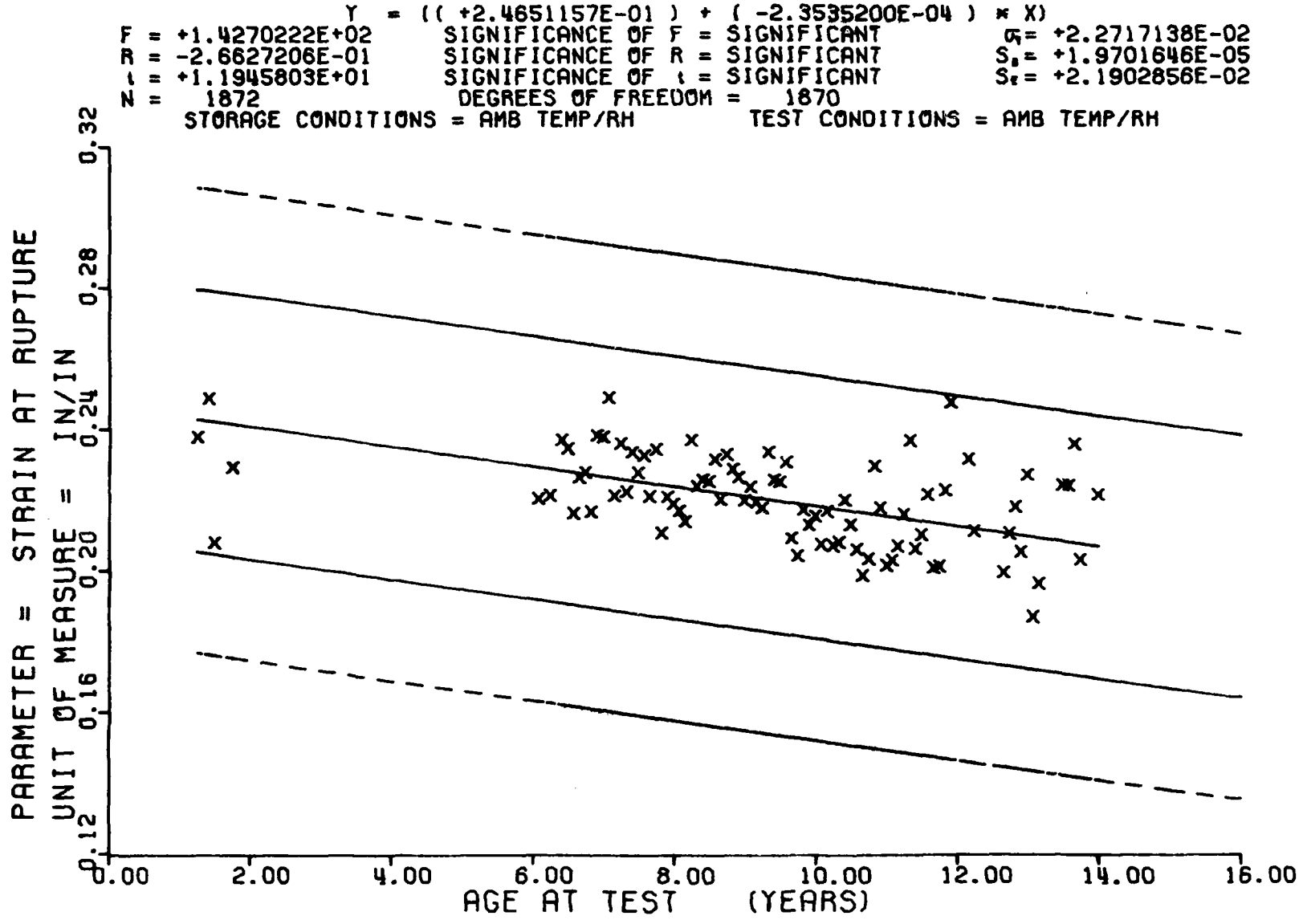

Y = ((+2.4651157E-01) + (-2.3535200E-04) * X)
F = +1.4270222E+02 SIGNIFICANCE OF F = SIGNIFICANT
R = -2.6627206E-01 SIGNIFICANCE OF R = SIGNIFICANT
t = +1.1945803E+01 SIGNIFICANCE OF t = SIGNIFICANT
N = 1872 DEGREES OF FREEDOM = 1870
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = IN/IN
0.12
0.16
0.20
0.24
0.28
0.32
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 VERY LOW RATE CHS=0.002 IN/MIN STRAIN AT RUPTURE (ER)

Figure 3

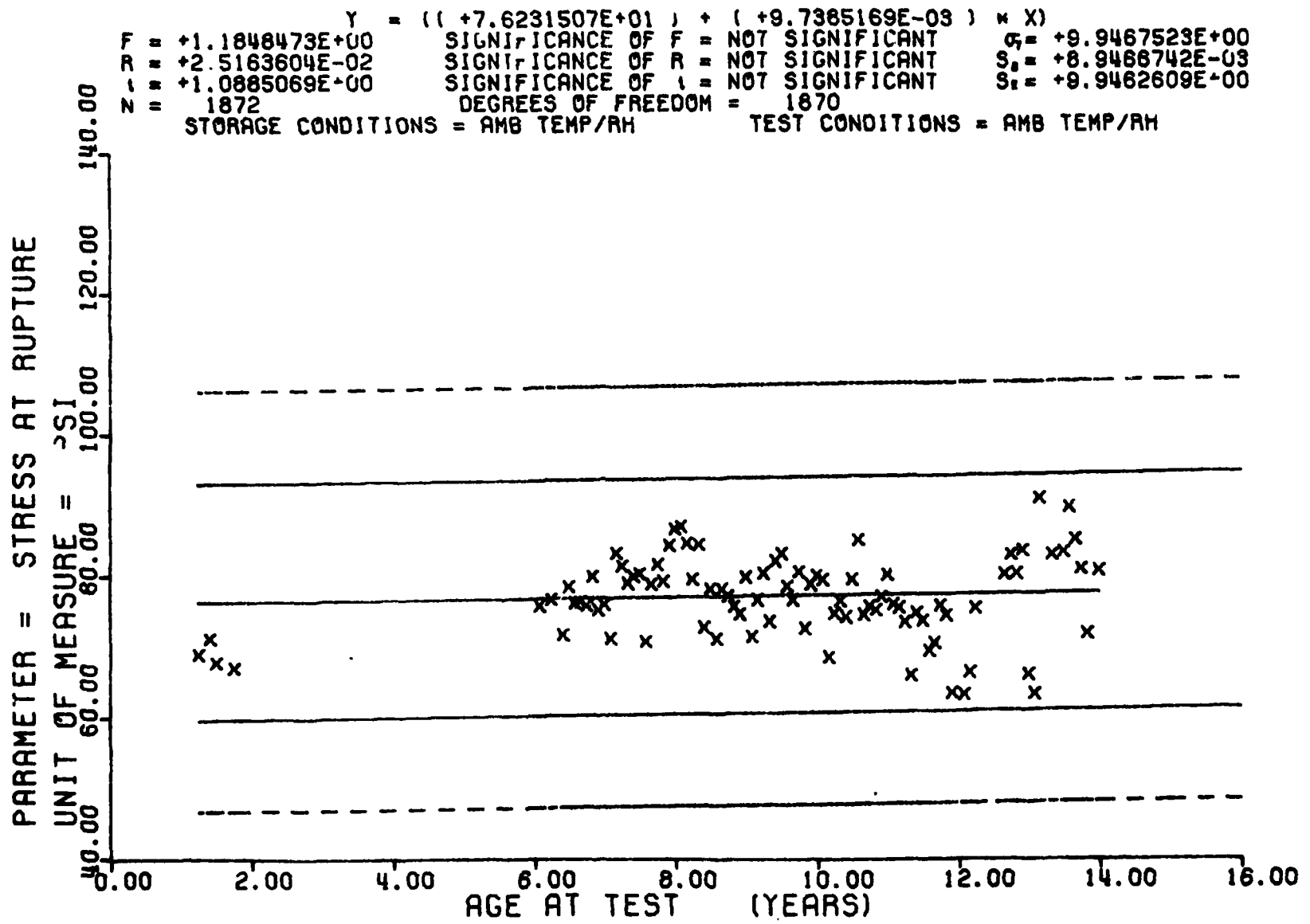

Y = ((+7.6231507E+01) + (+9.7385169E-03) * X)
F = +1.1848473E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σ1 = +9.9467523E+00
R = +2.5163604E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT Sa = +8.9466742E-03
t = +1.0885069E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT St = +9.9462609E+00
N = 1872 DEGREES OF FREEDOM = 1870
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRESS AT RUPTURE
UNIT OF MEASURE = PSI
140.00
120.00
100.00
80.00
60.00
40.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 VERY LOW RATE CHS=0.002 IN/MIN STRESS AT RUPTURE (SR)

Figure 4

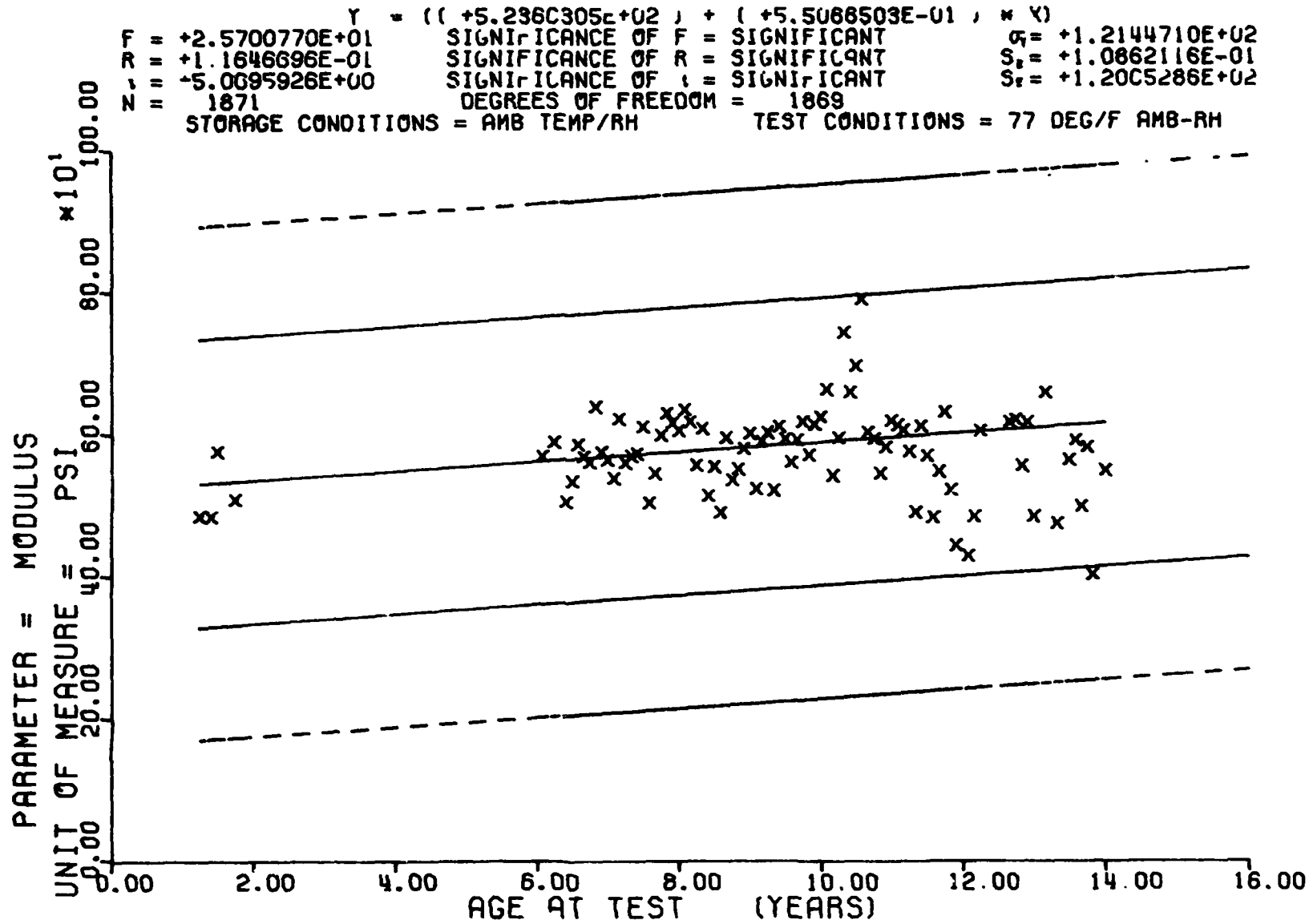

Y = ((+5.236C305E+02) + (+5.5066503E-01) * X)
F = +2.5700770E+01 SIGNIFICANCE OF F = SIGNIFICANT
R = +1.1646696E-01 SIGNIFICANCE OF R = SIGNIFICANT
N = 1871 DEGREES OF FREEDOM = 1869
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = 77 DEG/F AMB-RH
PARAMETER = MODULUS
UNIT OF MEASURE = PSI
0.00
20.00
40.00
60.00
80.00
100.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
AGE AT TEST (YEARS)
STAGE 1,WING 1&2 VERY LOW RATE CHS=0.002 IN/MIN MODULUS (E)

Figure 5

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
72.0	142	97.0	143	122.0	75	147.0	39
73.0	99	98.0	235	123.0	174	148.0	3
74.0	133	99.0	215	124.0	160	150.0	3
75.0	252	100.0	210	125.0	198	151.0	6
76.0	147	101.0	186	126.0	170	152.0	36
77.0	157	102.0	174	127.0	183	153.0	182
78.0	153	103.0	177	128.0	156	154.0	95
79.0	134	104.0	151	129.0	186	155.0	51
80.0	194	105.0	217	130.0	160	156.0	15
81.0	153	106.0	274	131.0	191	157.0	27
82.0	260	107.0	153	132.0	221	158.0	9
83.0	166	108.0	254	133.0	158	159.0	6
84.0	183	109.0	182	134.0	215	160.0	24
85.0	307	110.0	165	135.0	281	161.0	15
86.0	144	111.0	171	136.0	264	162.0	12
87.0	467	112.0	322	137.0	198	163.0	39
88.0	682	113.0	155	138.0	135	164.0	27
89.0	783	114.0	213	139.0	168	165.0	24
90.0	506	115.0	193	140.0	76	166.0	30
91.0	558	116.0	204	141.0	196	167.0	21
92.0	527	117.0	220	142.0	97	168.0	21
93.0	297	118.0	228	143.0	33	169.0	5
94.0	365	119.0	162	144.0	45		
95.0	311	120.0	188	145.0	27		
96.0	212	121.0	238	146.0	3		

STAGE 1.WING 162 LOW RATE TENSILE CHS=2.0 IN/MIN STRAIN AT MAX STRESS (EM)

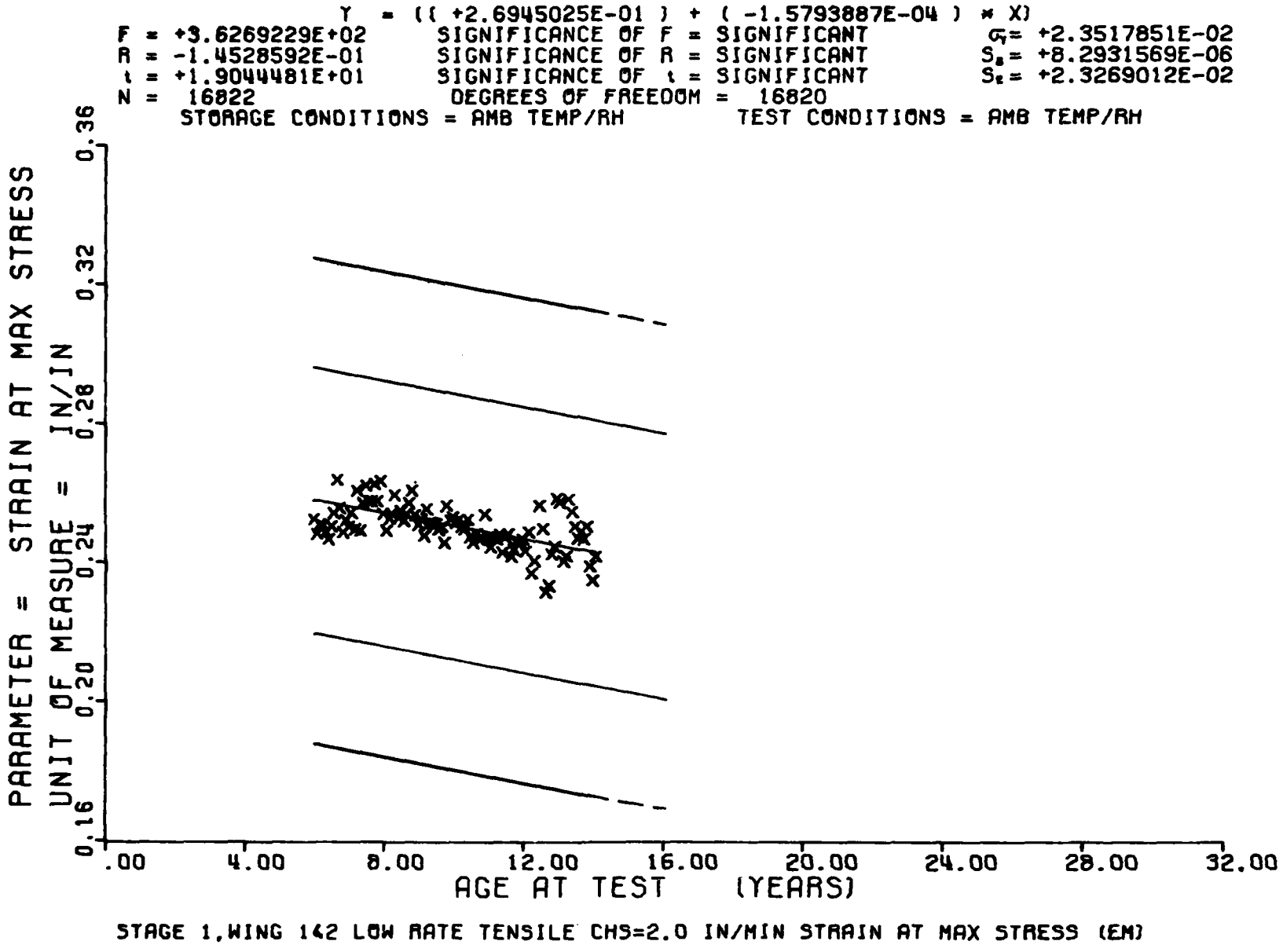

Y = ((+2.6945025E-01) + (-1.5793887E-04) * X)
F = +3.6269229E+02 SIGNIFICANCE OF F = SIGNIFICANT σ1= +2.3517851E-02
R = -1.4528592E-01 SIGNIFICANCE OF R = SIGNIFICANT Sa= +8.2931569E-06
t = +1.9044481E+01 SIGNIFICANCE OF t = SIGNIFICANT St= +2.3269012E-02
N = 16822 DEGREES OF FREEDOM = 16820
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.36
0.32
0.28
0.24
0.20
0.16
.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 LOW RATE TENSILE CHS=2.0 IN/MIN STRAIN AT MAX STRESS (EM)

Figure 6

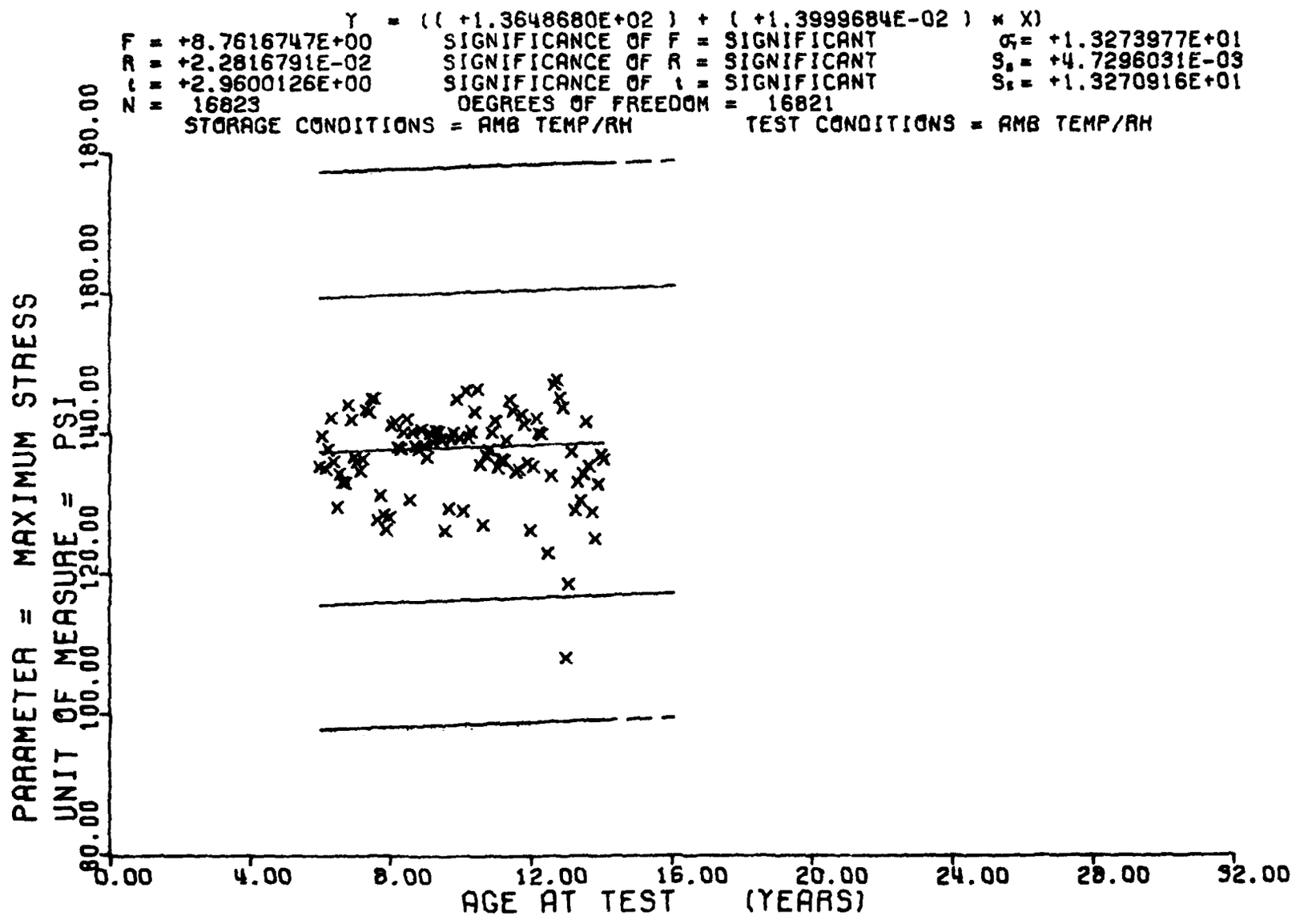

Y = ((+1.3648680E+02) + (+1.3999684E-02) * X)
F = +8.7616747E+00 SIGNIFICANCE OF F = SIGNIFICANT σ = +1.3273977E+01
R = +2.2816791E-02 SIGNIFICANCE OF R = SIGNIFICANT S = +4.7296031E-03
t = +2.9600126E+00 SIGNIFICANCE OF t = SIGNIFICANT S = +1.3270916E+01
N = 16823 DEGREES OF FREEDOM = 16821
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
80.00
100.00
120.00
140.00
160.00
180.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 LOW RATE TENSILE CHS=2.0 IN/MIN MAXIMUM STRESS (SM)

Figure 7

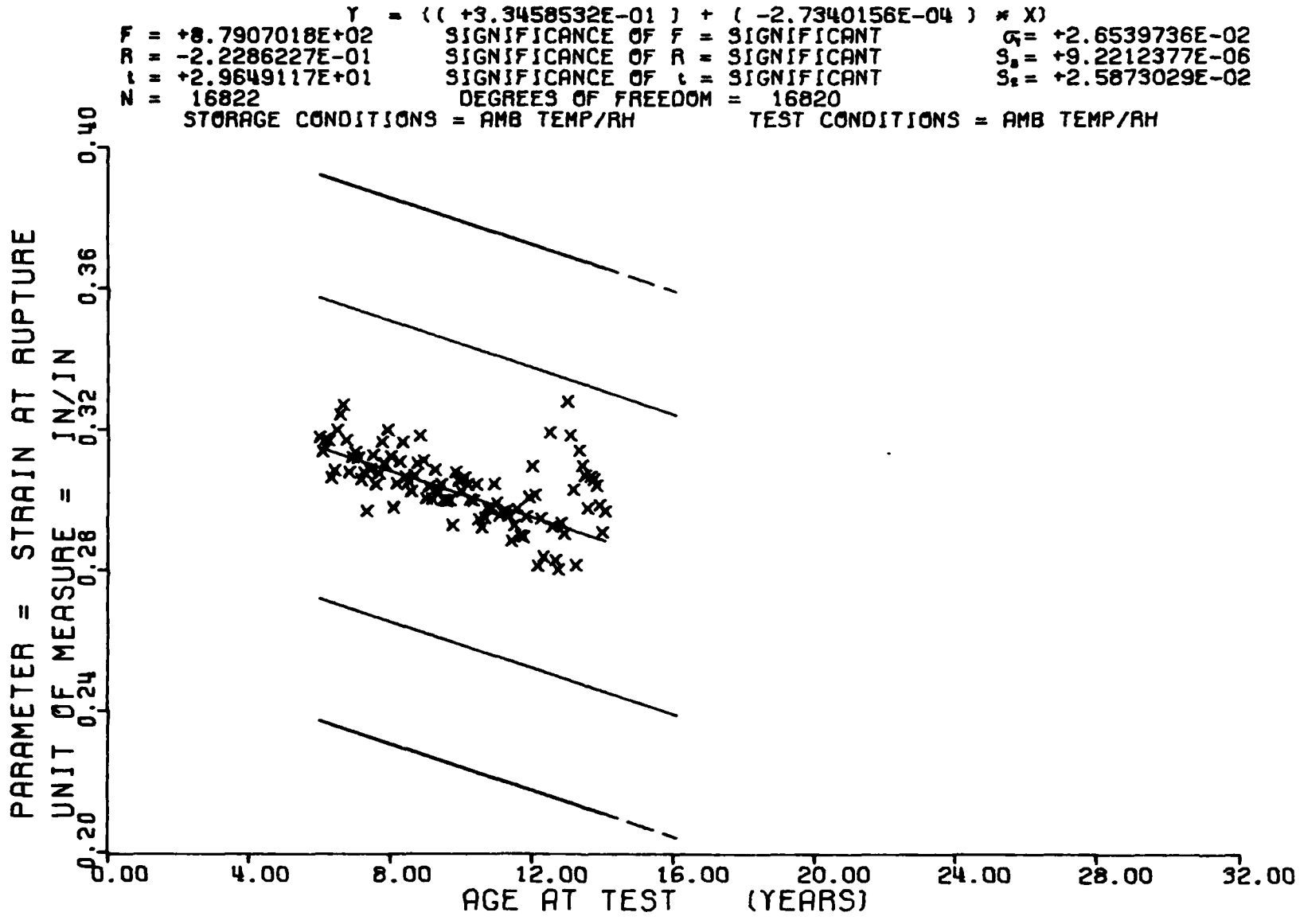

Y = ((+3.3458532E-01) + (-2.7340156E-04) * X)
F = +8.7907018E+02 SIGNIFICANCE OF F = SIGNIFICANT σ = +2.6539736E-02
R = -2.2286227E-01 SIGNIFICANCE OF R = SIGNIFICANT Sa = +9.2212377E-06
t = +2.9649117E+01 SIGNIFICANCE OF t = SIGNIFICANT Se = +2.5873029E-02
N = 16822 DEGREES OF FREEDOM = 16820
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = IN/IN
0.40
0.36
0.32
0.28
0.24
0.20
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 1&2 LOW RATE TENSILE CHS=2.0 IN/MIN STRAIN AT RUPTURE (ER)

Figure 8

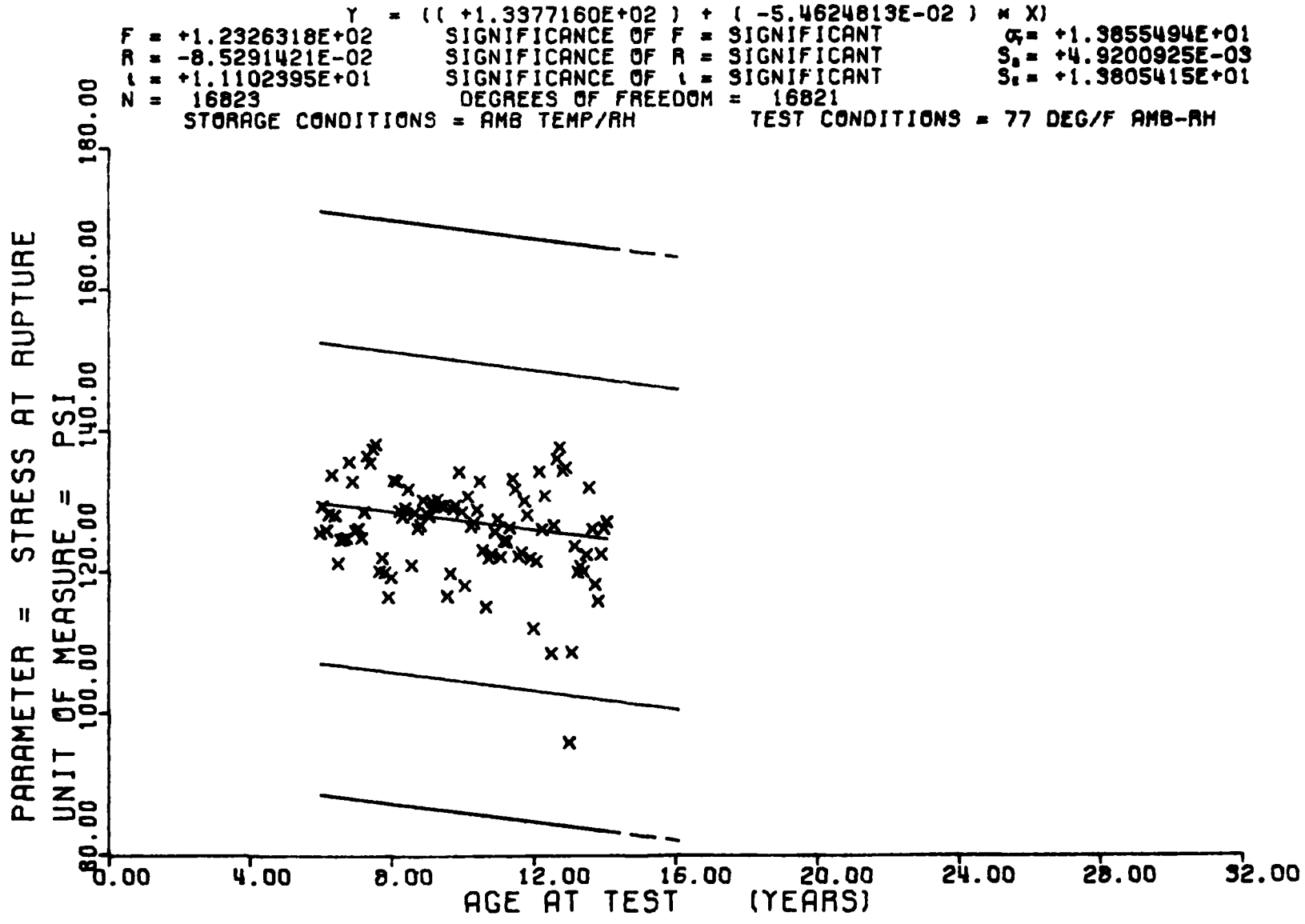
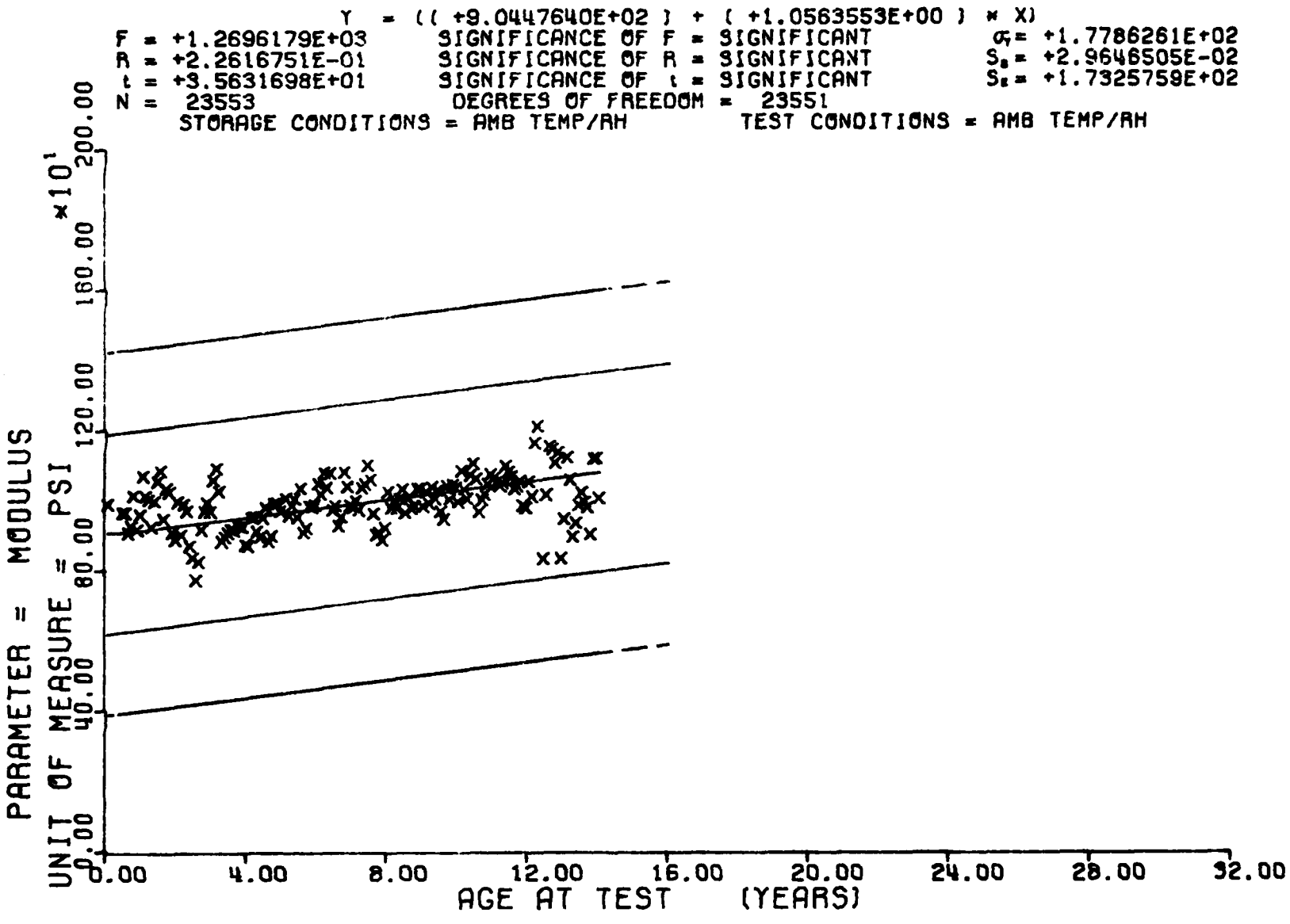

Y = ((+1.3377160E+02) + (-5.4624813E-02) * X)
F = +1.2326318E+02 SIGNIFICANCE OF F = SIGNIFICANT σ = +1.3855494E+01
R = -8.5291421E-02 SIGNIFICANCE OF R = SIGNIFICANT S = +4.9200925E-03
t = +1.1102395E+01 SIGNIFICANCE OF t = SIGNIFICANT S = +1.3805415E+01
N = 16823 DEGREES OF FREEDOM = 16821
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = 77 DEG/F AMB-RH
PARAMETER = STRESS AT RUPTURE
UNIT OF MEASURE = PSI
180.00
160.00
140.00
120.00
100.00
80.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 LOW RATE TENSILE CHS=2.0 IN/MIN STRESS AT RUPTURE (SR)

Figure 9

*** SAMPLE SIZE SUMMARY ***

AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	Age Months	Nr Samples	Age Months	Nr Sampl
1.0	1	30.0	391	55.0	24	81.0	153	106	272	138	135
6.0	4	31.0	307	56.0	18	82.0	260	107	153	139	168
7.0	33	32.0	215	57.0	30	83.0	166	108	253	140	76
8.0	53	33.0	114	58.0	24	84.0	183	109	179	141	196
9.0	49	34.0	91	59.0	24	85.0	307	110	165	142	97
10.0	89	35.0	57	60.0	42	86.0	144	111	171	143	33
11.0	43	36.0	63	62.0	24	87.0	467	112	322	144	45
12.0	46	37.0	56	63.0	51	88.0	682	113	155	145	27
13.0	44	38.0	75	64.0	61	89.0	783	114	213	146	3
14.0	65	39.0	68	65.0	42	90.0	506	115	193	147	39
15.0	43	40.0	54	66.0	96	91.0	558	116	204	148	3
16.0	70	41.0	84	67.0	39	92.0	527	117	220	150	3
17.0	42	42.0	216	68.0	69	93.0	297	118	228	151	6
18.0	75	43.0	241	69.0	97	94.0	366	119	162	152	36
19.0	127	44.0	158	70.0	89	95.0	311	120	238	153	182
20.0	65	45.0	194	71.0	165	96.0	212	121	188	154	95
21.0	55	46.0	136	72.0	142	97.0	143	122	75	155	51
22.0	51	47.0	53	73.0	99	98.0	235	123	174	156	15
23.0	79	48.0	36	74.0	133	99.0	215	124	160	157	24
24.0	338	49.0	27	75.0	252	100.0	210	125	198	158	9
25.0	210	50.0	17	76.0	147	101.0	186	126	170	159	3
26.0	251	51.0	16	77.0	157	102.0	174	127	183	160	24
27.0	391	52.0	21	78.0	154	103.0	177	128	156	161	15
28.0	354	53.0	6	79.0	134	104.0	151	129	186	162	12
29.0	517	54.0	3	80.0	194	105.0	217	130	160	163	39
								131	191	164	27
								132	221	165	24
								133	158	166	30
								134	215	167	21
								135	281	168	20
								136	264	169	5
								137	198		

STAGE 1,WING 1-2 LOW RATE TENSILE CHS 2.0 INCMIN MODULUS E



STAGE 1,WING 142 LOW RATE TENSILE CHS=2.0 IN/MIN MODULUS (E)

Figure 10

*** SAMPLE SIZE SUMMARY ***

AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES
72.0	3	97.0	5	122.0	16	155.0	3
73.0	9	98.0	1	123.0	6	156.0	2
74.0	4	99.0	3	124.0	13	157.0	4
75.0	5	100.0	5	125.0	5	161.0	2
76.0	9	101.0	2	126.0	11	163.0	1
77.0	12	102.0	4	127.0	6	164.0	3
78.0	7	103.0	4	128.0	8	165.0	1
79.0	16	104.0	5	129.0	7	166.0	3
80.0	5	105.0	5	130.0	7	169.0	1
81.0	10	106.0	9	131.0	4		
82.0	15	107.0	10	132.0	4		
83.0	13	108.0	11	133.0	4		
84.0	11	109.0	12	134.0	6		
85.0	11	110.0	8	135.0	13		
86.0	18	111.0	12	136.0	16		
87.0	11	112.0	10	137.0	10		
88.0	14	113.0	8	138.0	6		
89.0	26	114.0	6	139.0	1		
90.0	34	115.0	11	140.0	2		
91.0	23	116.0	5	141.0	5		
92.0	37	117.0	8	142.0	5		
93.0	30	118.0	5	148.0	1		
94.0	20	119.0	4	152.0	1		
95.0	11	120.0	12	153.0	5		
96.0	10	121.0	11	154.0	3		

STAGE 1,WING 1-2 LOW RATE BIAXIAL CYS 0.2 IN&MIN STRAIN AT MAX STRESS EM

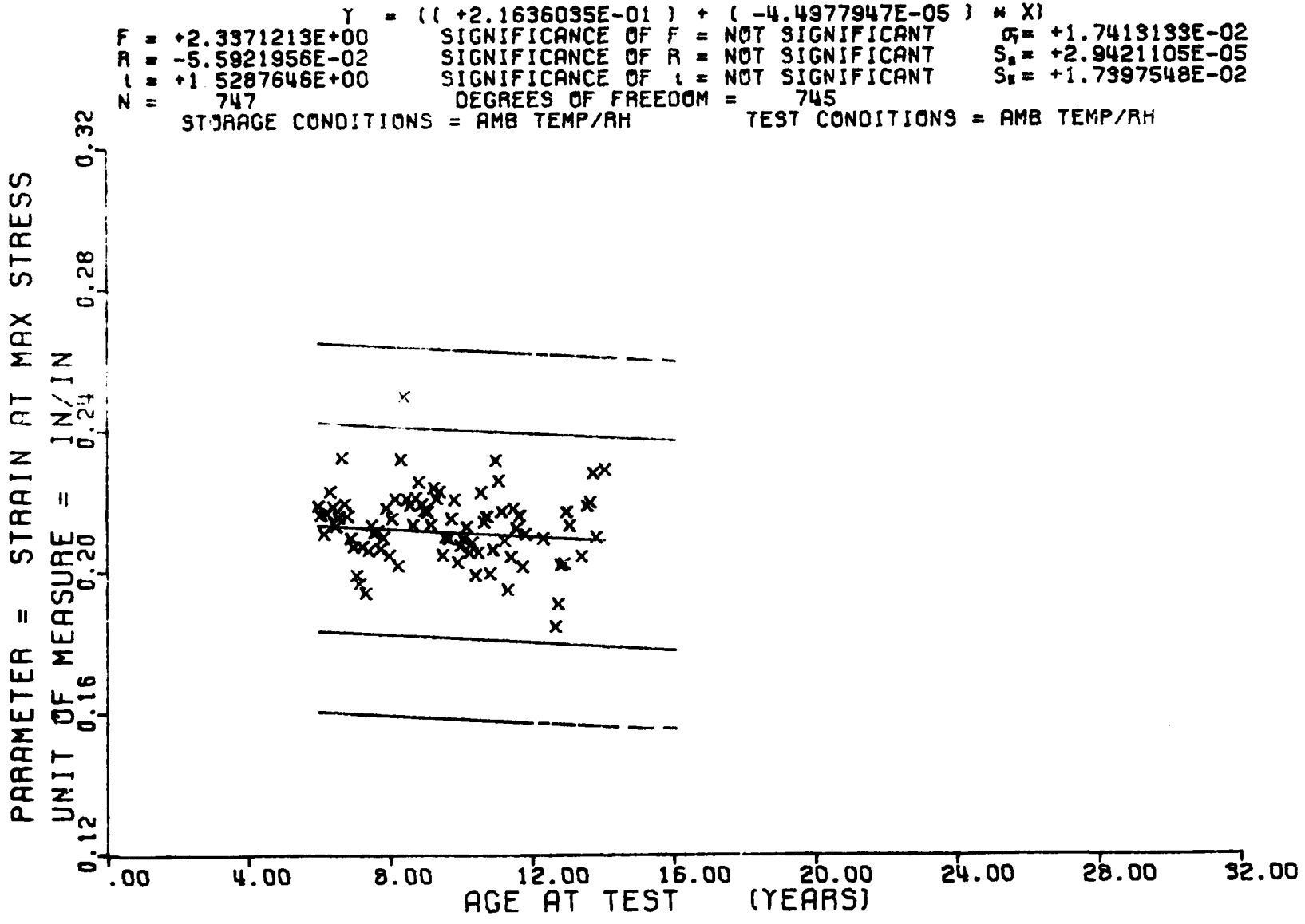

Y = ((+2.1636035E-01) + (-4.4977947E-05) * X)
F = +2.3371213E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σ = +1.7413133E-02
R = -5.5921956E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT S = +2.9421105E-05
t = +1.5287646E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT S = +1.7397548E-02
N = 747 DEGREES OF FREEDOM = 745
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.12
0.16
0.20
0.24
0.28
0.32
.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 LOW RATE BIAXIAL CHS=0.2 IN/MIN STRAIN AT MAX STRESS (EM)

Figure 11

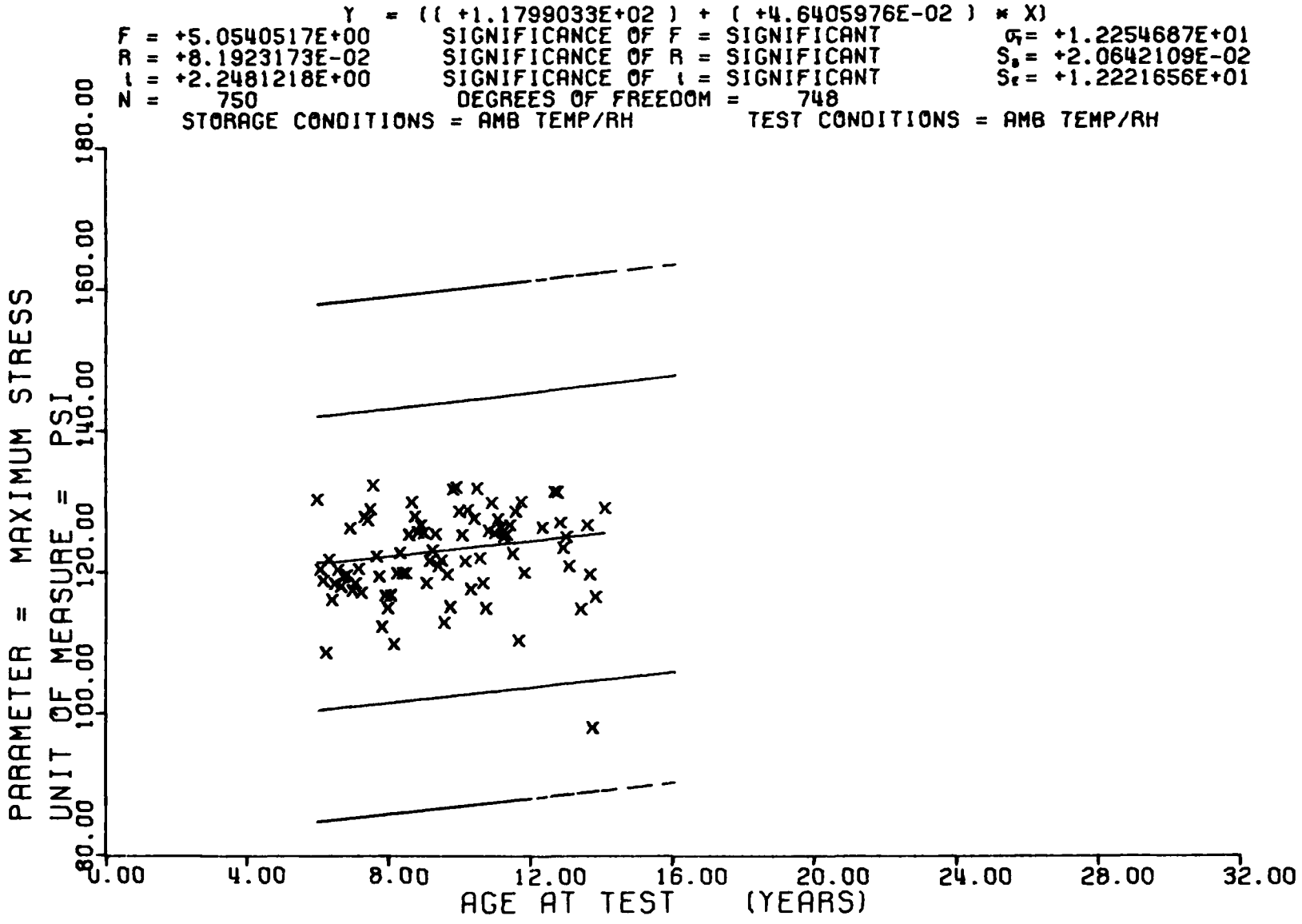

Y = ((+1.1799033E+02) + (+4.6405976E-02) * X)
F = +5.0540517E+00 SIGNIFICANCE OF F = SIGNIFICANT σr= +1.2254687E+01
R = +8.1923173E-02 SIGNIFICANCE OF R = SIGNIFICANT Se= +2.0642109E-02
t = +2.2481218E+00 SIGNIFICANCE OF t = SIGNIFICANT Sr= +1.2221656E+01
N = 750 DEGREES OF FREEDOM = 748
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
80.00
100.00
120.00
140.00
160.00
180.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 1&2 LOW RATE BIAXIAL CHS=0.2 IN/MIN MAXIMUM STRESS (SM)

Figure 12

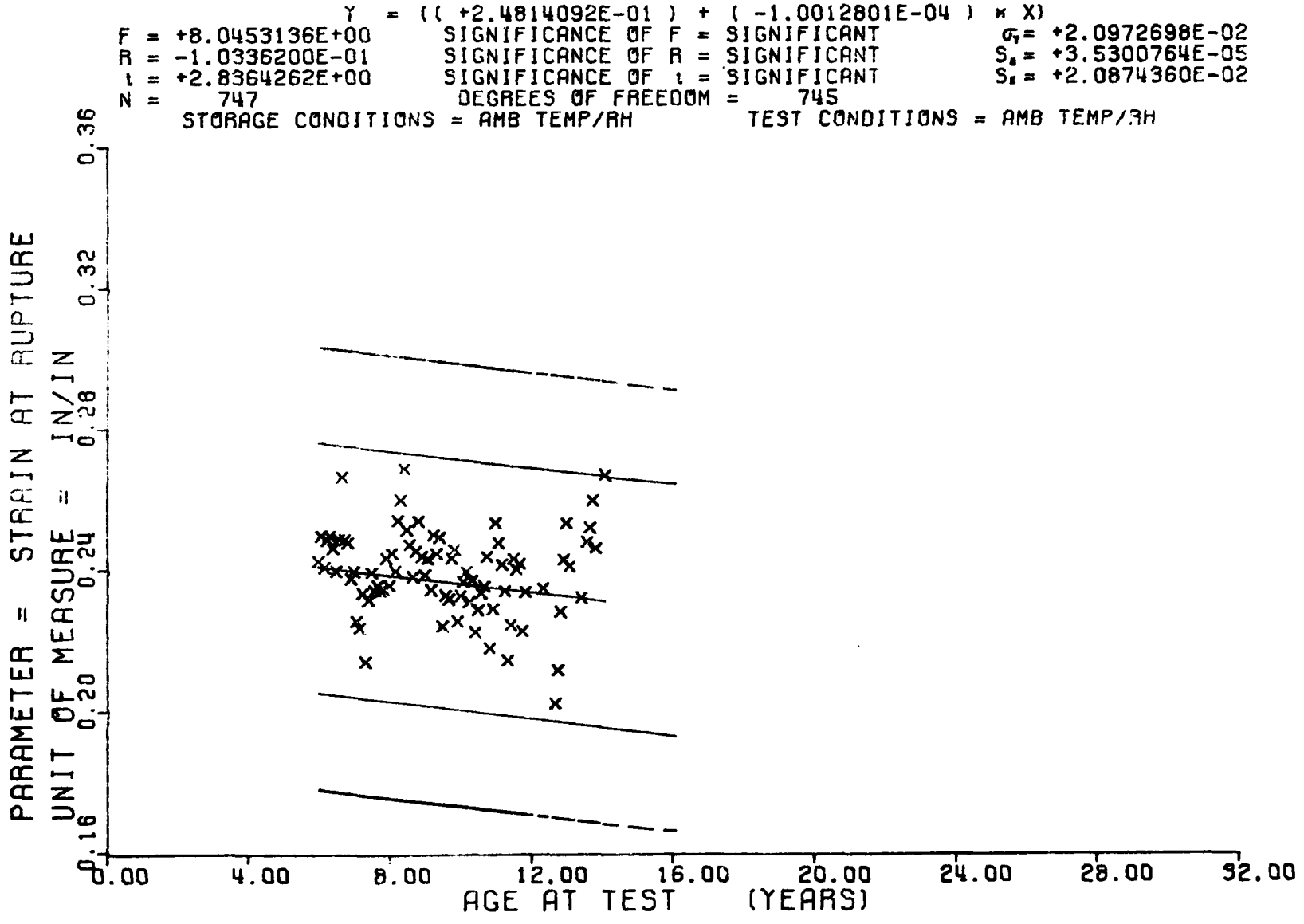

Y = ((+2.4814092E-01) + (-1.0012801E-04) * X)
F = +8.0453136E+00 SIGNIFICANCE OF F = SIGNIFICANT σr = +2.0972698E-02
R = -1.0336200E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +3.5300764E-05
t = +2.8364262E+00 SIGNIFICANCE OF t = SIGNIFICANT Sx = +2.0874360E-02
N = 747 DEGREES OF FREEDOM = 745
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = IN/IN
0.36
0.32
0.28
0.24
0.20
0.16
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 LOW RATE BIAXIAL CHS=0.2 IN/MIN STRAIN AT RUPTURE (EA)

Figure 13

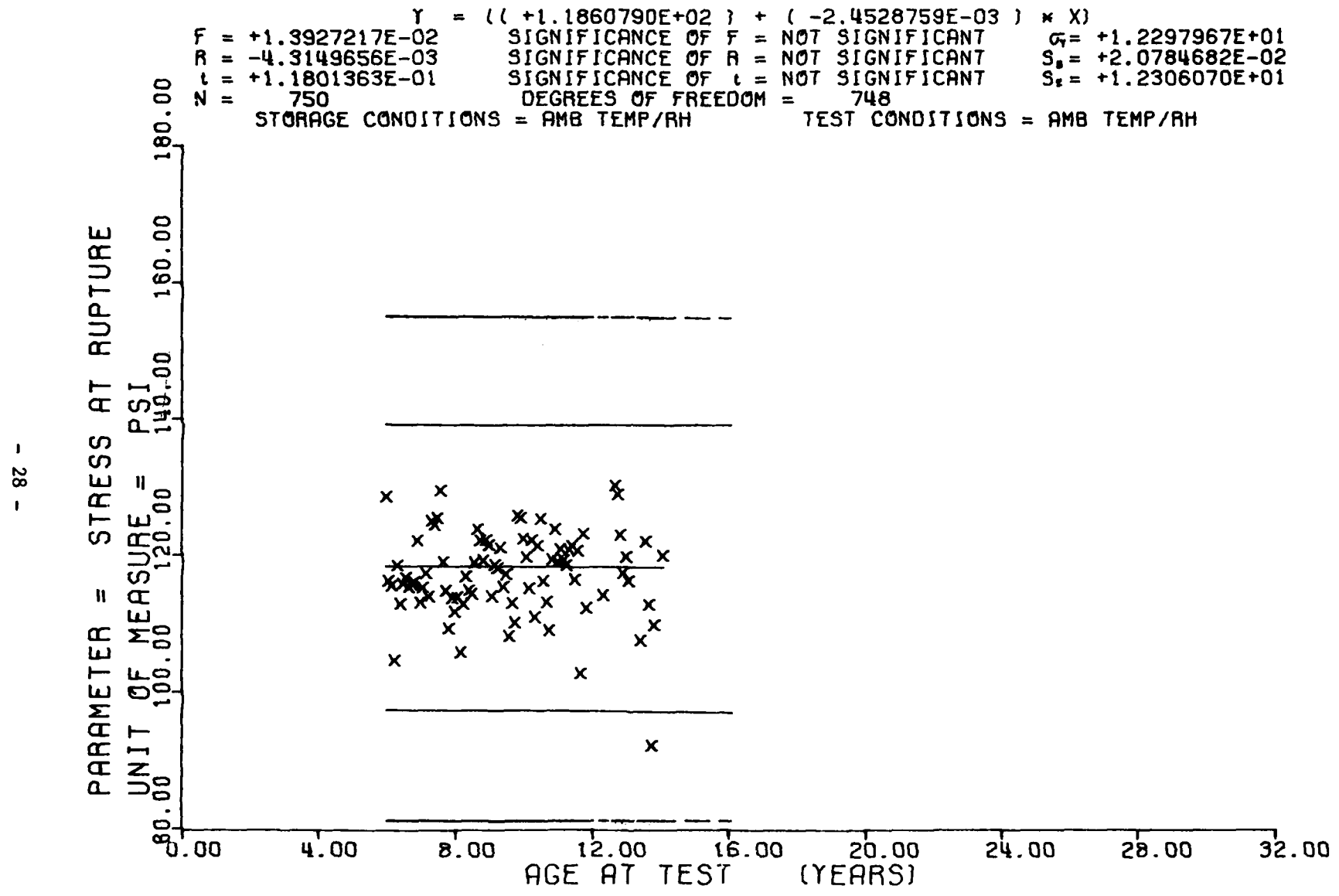
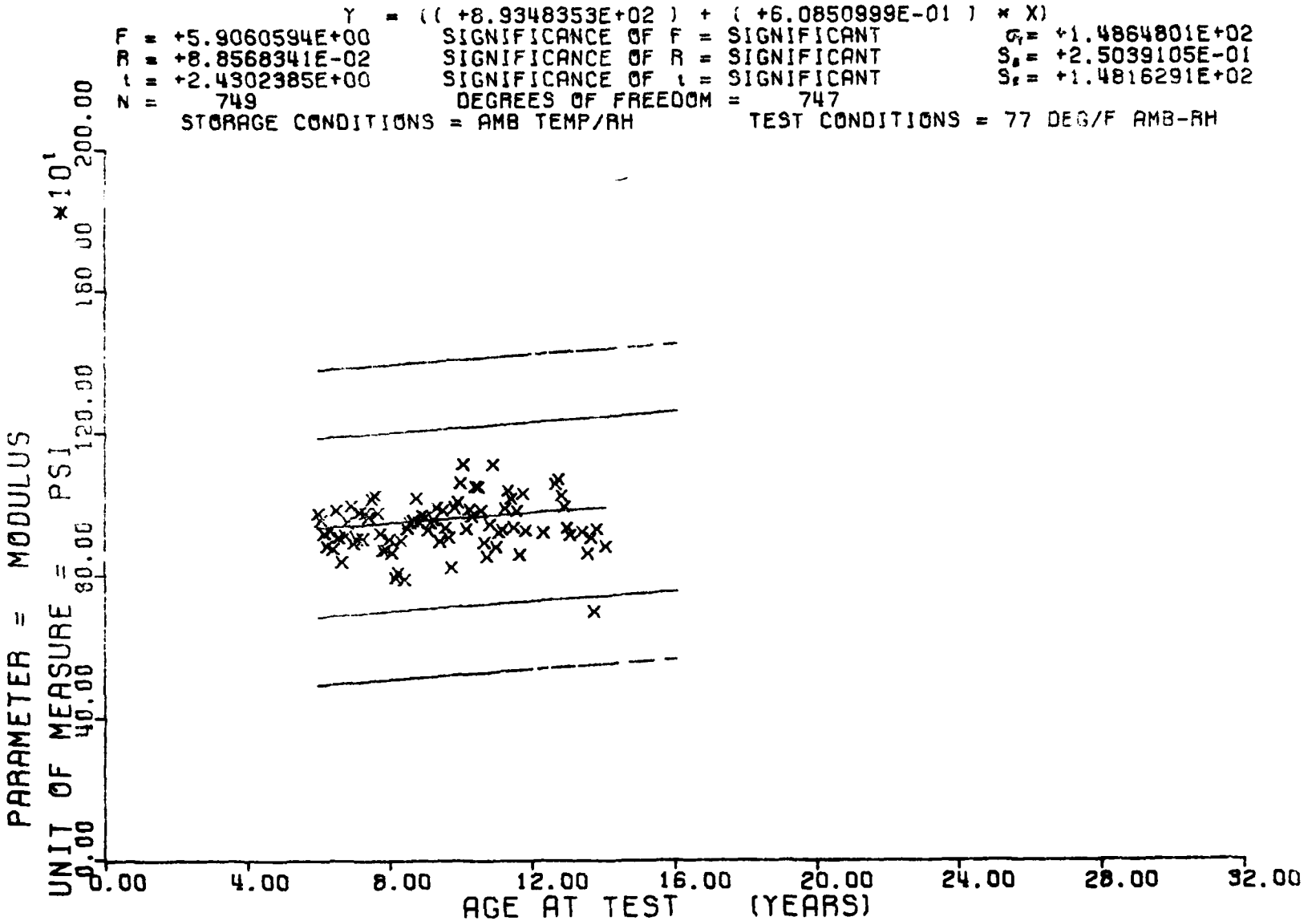

Y = ((+1.1860790E+02) + (-2.4528759E-03) * X)
F = +1.3927217E-02 SIGNIFICANCE OF F = NOT SIGNIFICANT σ = +1.2297967E+01
R = -4.3149656E-03 SIGNIFICANCE OF R = NOT SIGNIFICANT S = +2.0784682E-02
t = +1.1801363E-01 SIGNIFICANCE OF t = NOT SIGNIFICANT S = +1.2306070E+01
N = 750 DEGREES OF FREEDOM = 748
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRESS AT RUPTURE
UNIT OF MEASURE = PSI
180.00
160.00
140.00
120.00
100.00
80.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 1&2 LOW RATE BIAXIAL CHS=0.2 IN/MIN STRESS AT RUPTURE (SR)

Figure 14



STAGE 1,WING 1&2 LOW RATE BIAXIAL CH9=0.2 IN/MIN MODULUS (E)

Figure 15

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
72.0	21	97.0	26	122.0	36	152.0	9
73.0	24	98.0	24	123.0	30	153.0	21
74.0	12	99.0	18	124.0	9	154.0	12
75.0	18	100.0	15	125.0	30	155.0	9
76.0	9	101.0	18	126.0	21	157.0	9
77.0	45	102.0	18	127.0	38	160.0	3
78.0	18	103.0	20	128.0	12	162.0	3
79.0	36	104.0	42	129.0	18	163.0	3
80.0	27	105.0	27	130.0	15	164.0	6
81.0	21	106.0	31	131.0	18	165.0	12
82.0	63	107.0	18	132.0	36	167.0	5
83.0	24	108.0	21	133.0	29	168.0	10
84.0	39	109.0	23	134.0	20	191.0	4
85.0	22	110.0	30	135.0	45		
86.0	20	111.0	52	136.0	37		
87.0	69	112.0	20	137.0	33		
88.0	101	113.0	48	138.0	28		
89.0	75	114.0	26	139.0	18		
90.0	85	115.0	18	140.0	27		
91.0	66	116.0	35	141.0	11		
92.0	96	117.0	25	142.0	12		
93.0	49	118.0	16	143.0	37		
94.0	61	119.0	43	144.0	23		
95.0	42	120.0	42	146.0	6		
96.0	30	121.0	21	148.0	6		

STAGE 1.WING 162 HIGH RATE CHS=1750 IN/MIN STRAIN AT MAX STRESS (EM)

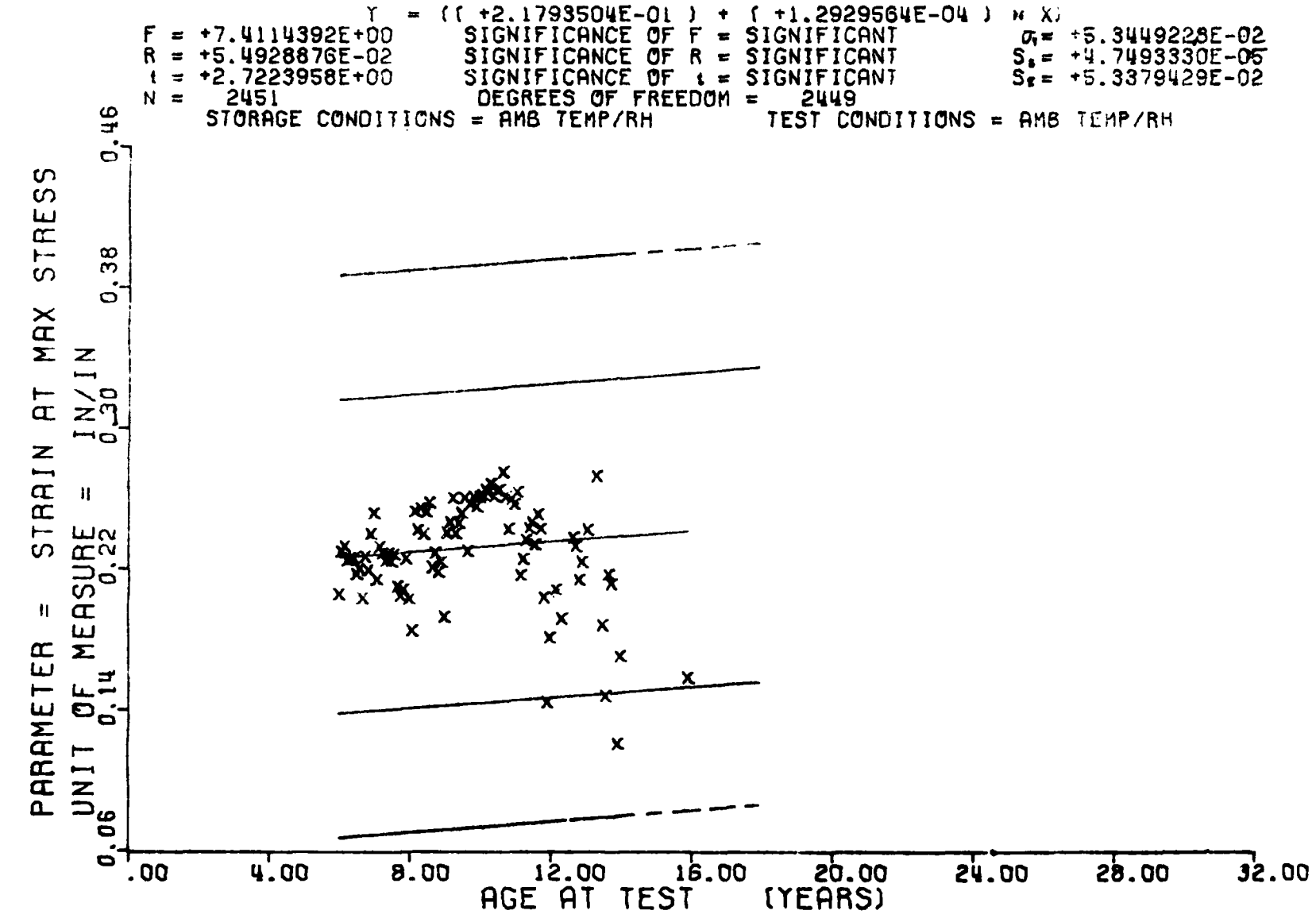

Y = (+2.1793504E-01) + (+1.2929564E-04) * X
F = +7.4114392E+00 SIGNIFICANCE OF F = SIGNIFICANT σ = +5.3449228E-02
R = +5.4928876E-02 SIGNIFICANCE OF R = SIGNIFICANT S = +4.7493330E-05
t = +2.7223958E+00 SIGNIFICANCE OF t = SIGNIFICANT S = +5.3379429E-02
N = 2451 DEGREES OF FREEDOM = 2449
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.46
0.38
0.30
0.22
0.14
0.06
.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 HIGH RATE CHS=1750 IN/MIN STRAIN AT MAX STRESS (EM)

Figure 16

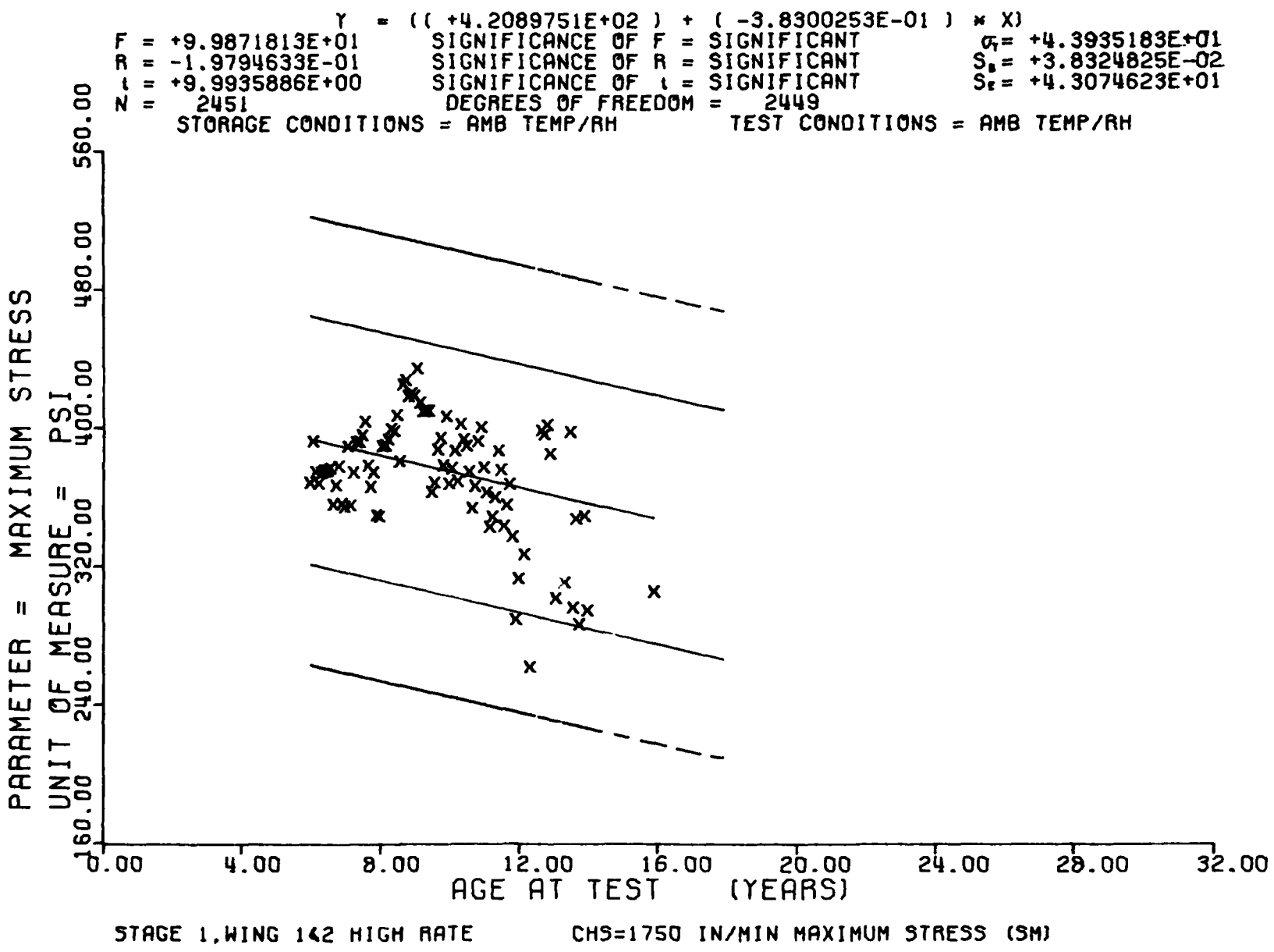

Y = ((+4.2089751E+02) + (-3.8300253E-01) * X)
F = +9.9871813E+01
SIGNIFICANCE OF F = SIGNIFICANT
σ_Y = +4.3935183E+01
R = -1.9794633E-01
SIGNIFICANCE OF R = SIGNIFICANT
S_B = +3.8324825E-02
t = +9.9935886E+00
SIGNIFICANCE OF t = SIGNIFICANT
S_E = +4.3074623E+01
N = 2451
DEGREES OF FREEDOM = 2449
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = AMB TEMP/RH
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
560.00
480.00
400.00
320.00
240.00
160.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 HIGH RATE
CHS=1750 IN/MIN MAXIMUM STRESS (SM)

Figure 17

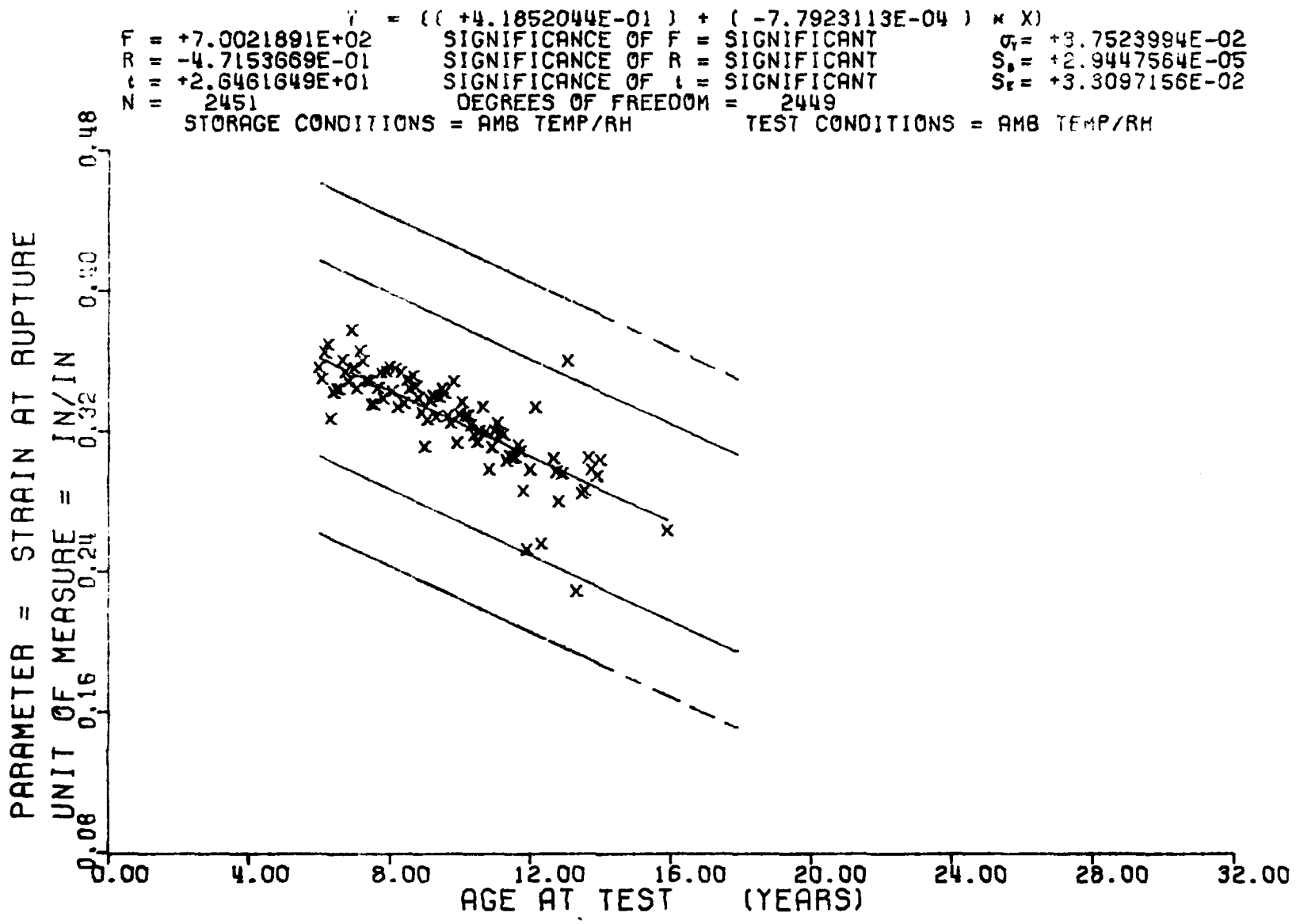

Y = ((+4.1852044E-01) + (-7.7923113E-04) * X)
F = +7.0021891E+02 SIGNIFICANCE OF F = SIGNIFICANT σ = +3.7523994E-02
R = -4.7153669E-01 SIGNIFICANCE OF R = SIGNIFICANT S = +2.9447564E-05
t = +2.6461649E+01 SIGNIFICANCE OF t = SIGNIFICANT S = +3.3097156E-02
N = 2451 DEGREES OF FREEDOM = 2449
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = IN/IN
0.08
0.16
0.24
0.32
0.40
0.48
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 HIGH RATE CHS=1750 IN/MIN STRAIN AT RUPTURE (ER)

Figure 18

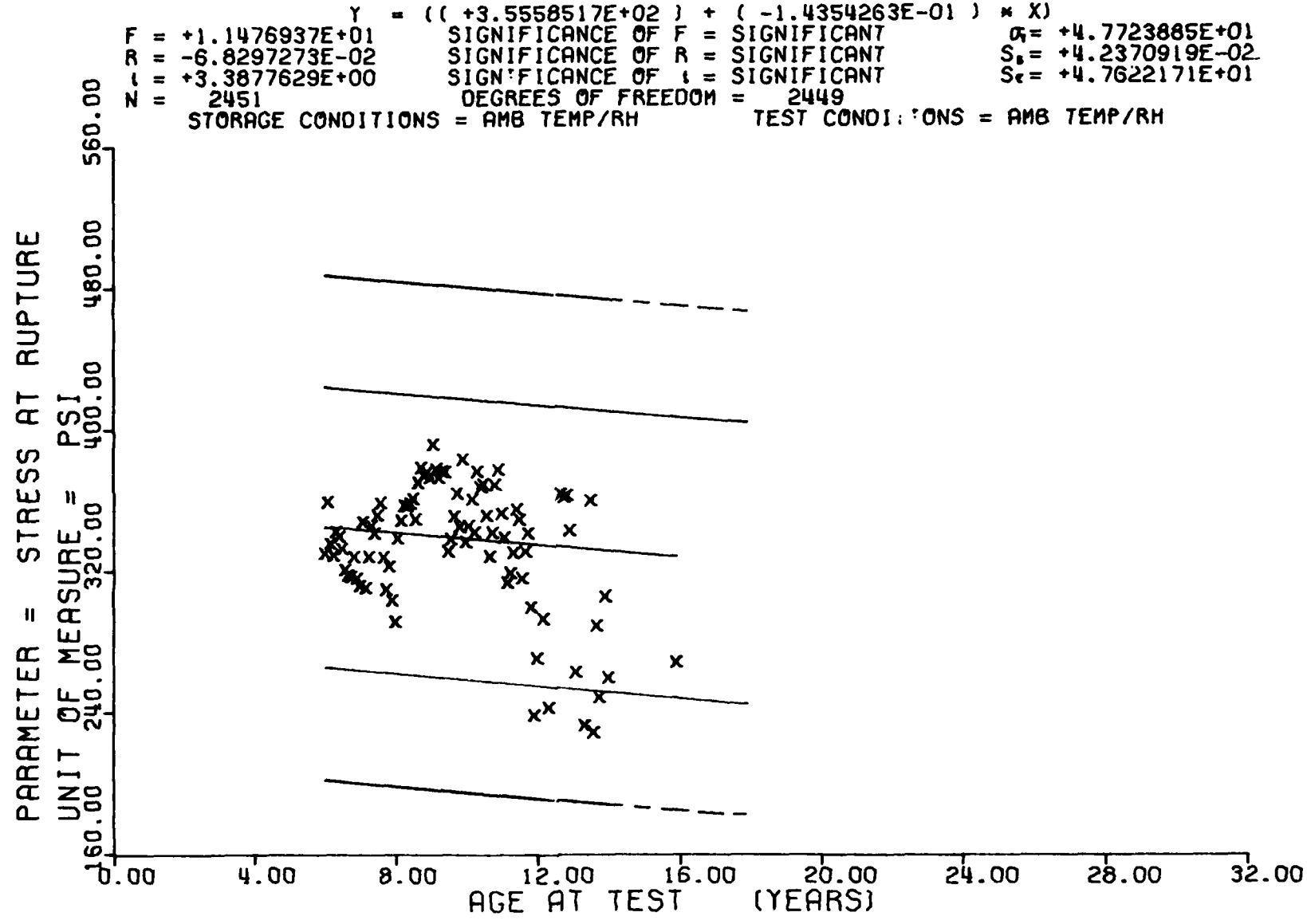

Y = ((+3.5558517E+02) + (-1.4354263E-01) * X)
F = +1.1476937E+01 SIGNIFICANCE OF F = SIGNIFICANT
R = -6.8297273E-02 SIGNIFICANCE OF R = SIGNIFICANT
t = +3.3877629E+00 SIGNIFICANCE OF t = SIGNIFICANT
N = 2451 DEGREES OF FREEDOM = 2449
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRESS AT RUPTURE
UNIT OF MEASURE = PSI
160.00
240.00
320.00
400.00
480.00
560.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 1&2 HIGH RATE
CHS=1750 IN/MIN STRESS AT RUPTURE (SR)

Figure 19

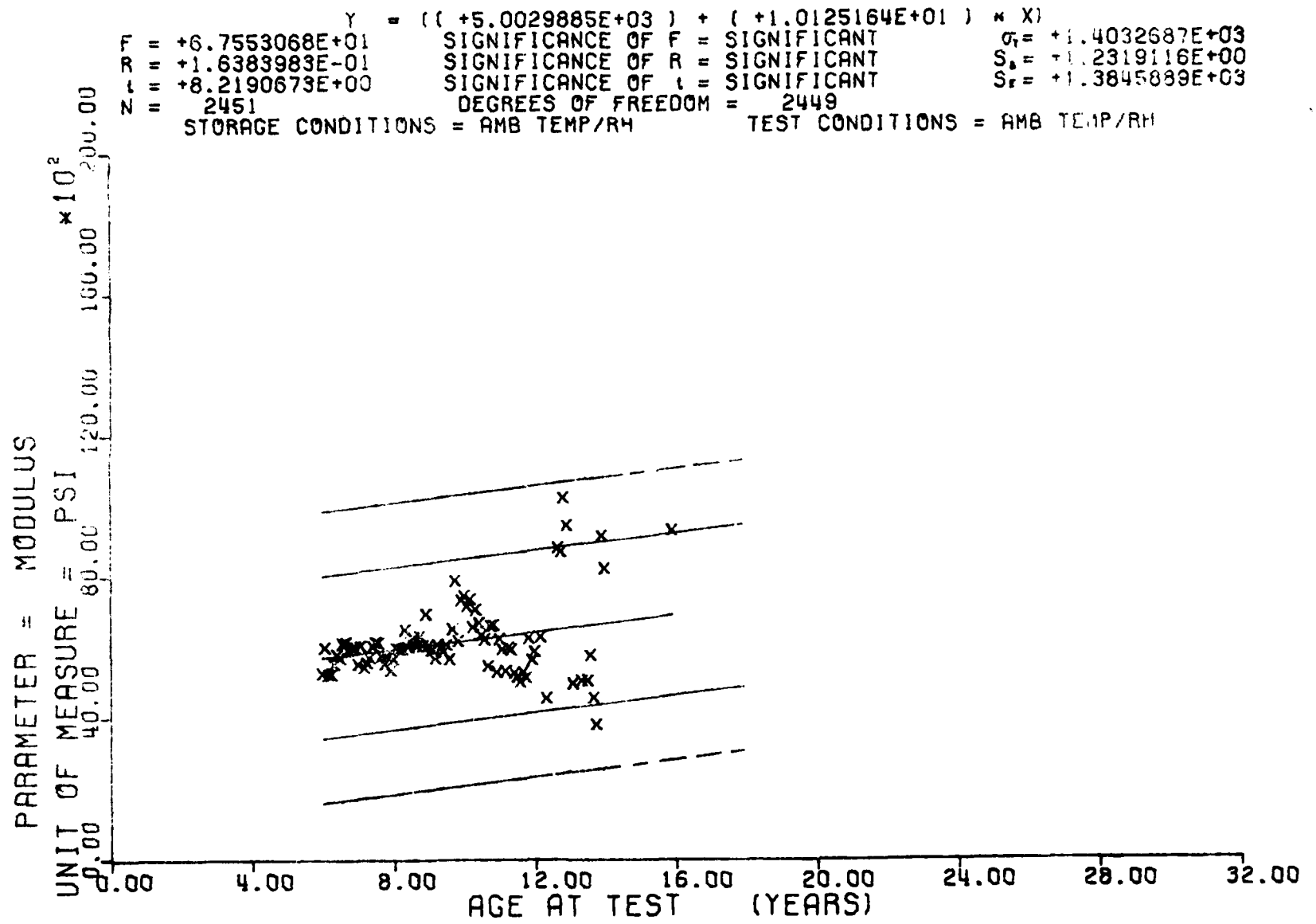

Y = ((+5.0029885E+03) + (+1.0125164E+01) * X)
F = +6.7553068E+01 SIGNIFICANCE OF F = SIGNIFICANT
R = +1.6383983E-01 SIGNIFICANCE OF R = SIGNIFICANT
t = +8.2190673E+00 SIGNIFICANCE OF t = SIGNIFICANT
N = 2451 DEGREES OF FREEDOM = 2449
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = MODULUS
UNIT OF MEASURE = PSI *10²
0.00
40.00
80.00
120.00
160.00
200.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 HIGH RATE CHS=1750 IN/MIN MODULUS (E)

Figure 20

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
72.0	9	97.0	8	122.0	15	147.0	2
73.0	4	98.0	18	123.0	6	148.0	1
74.0	7	99.0	19	124.0	9	149.0	1
75.0	17	100.0	10	125.0	16	150.0	2
76.0	5	101.0	8	126.0	3	153.0	8
77.0	9	102.0	10	127.0	7	154.0	3
78.0	10	103.0	5	128.0	10	155.0	7
79.0	5	104.0	7	129.0	8	156.0	3
80.0	11	105.0	7	130.0	7	157.0	1
81.0	4	106.0	12	131.0	3	160.0	3
82.0	13	107.0	13	132.0	8	163.0	2
83.0	7	108.0	14	133.0	12	164.0	1
84.0	4	109.0	8	134.0	12	166.0	2
85.0	15	110.0	12	135.0	2	168.0	4
86.0	5	111.0	7	136.0	8	169.0	3
87.0	14	112.0	14	137.0	6	171.0	6
88.0	21	113.0	7	138.0	3		
89.0	25	114.0	5	139.0	5		
90.0	28	115.0	6	140.0	3		
91.0	13	116.0	9	141.0	3		
92.0	5	117.0	8	142.0	2		
93.0	6	118.0	9	143.0	5		
94.0	8	119.0	11	144.0	10		
95.0	9	120.0	11	145.0	1		
96.0	8	121.0	9	146.0	3		

STAGE 1,WING 1&2 H.R. TRIAXIAL CHS=1750,PSI=600, MODULUS (E)

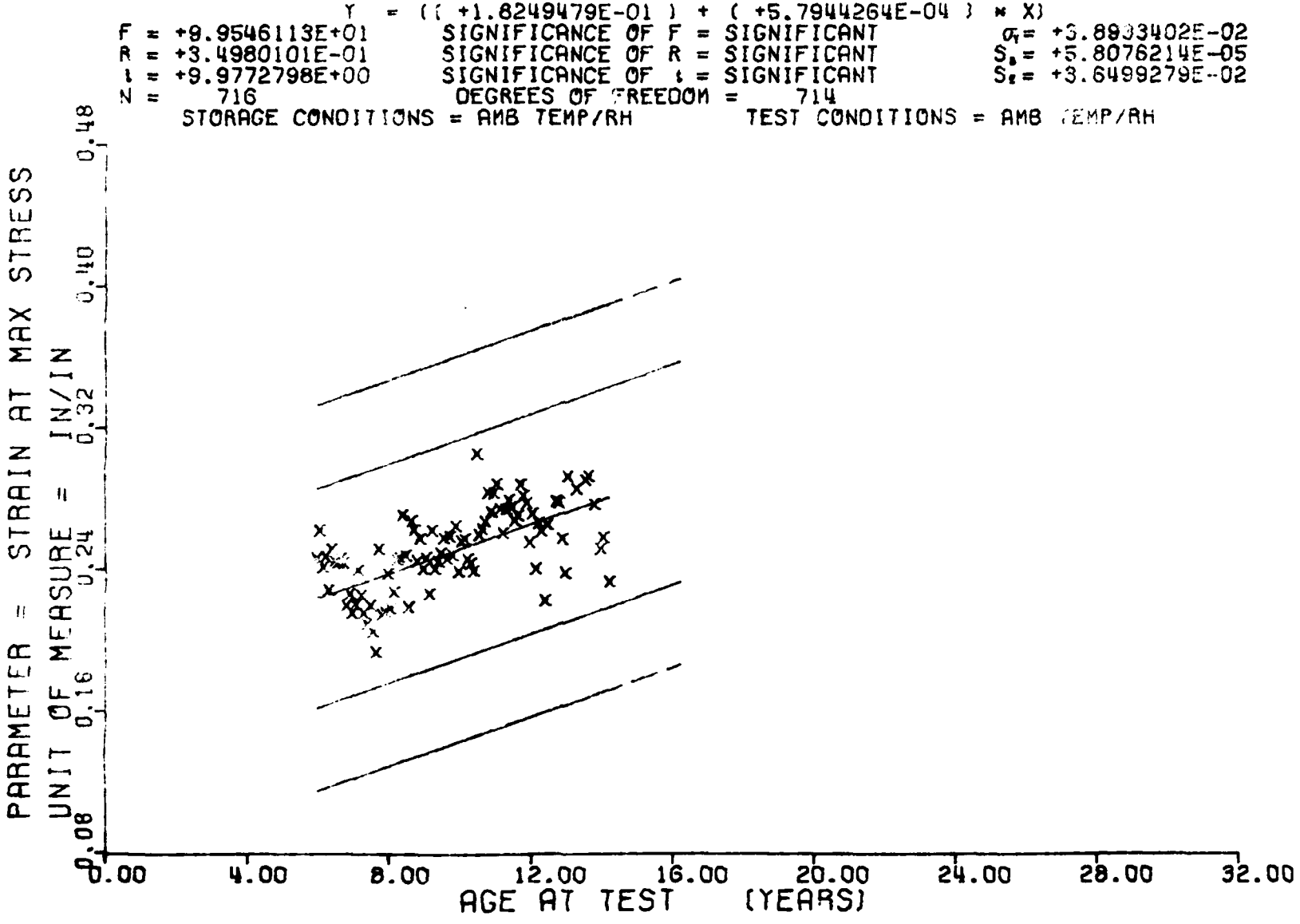

Y = (+1.8249479E-01) + (+5.7944264E-04) * X)
F = +9.9546113E+01 SIGNIFICANCE OF F = SIGNIFICANT σt = +3.8933402E-02
R = +3.4980101E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +5.8076214E-05
t = +9.9772798E+00 SIGNIFICANCE OF t = SIGNIFICANT Se = +3.6499279E-02
N = 716 DEGREES OF FREEDOM = 714
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.08
0.16
0.24
0.32
0.40
0.48
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 M.M. TRIAXIAL CHS=1750,PSI=600, STRAIN AT MAX STRESS (EM)

Figure 21

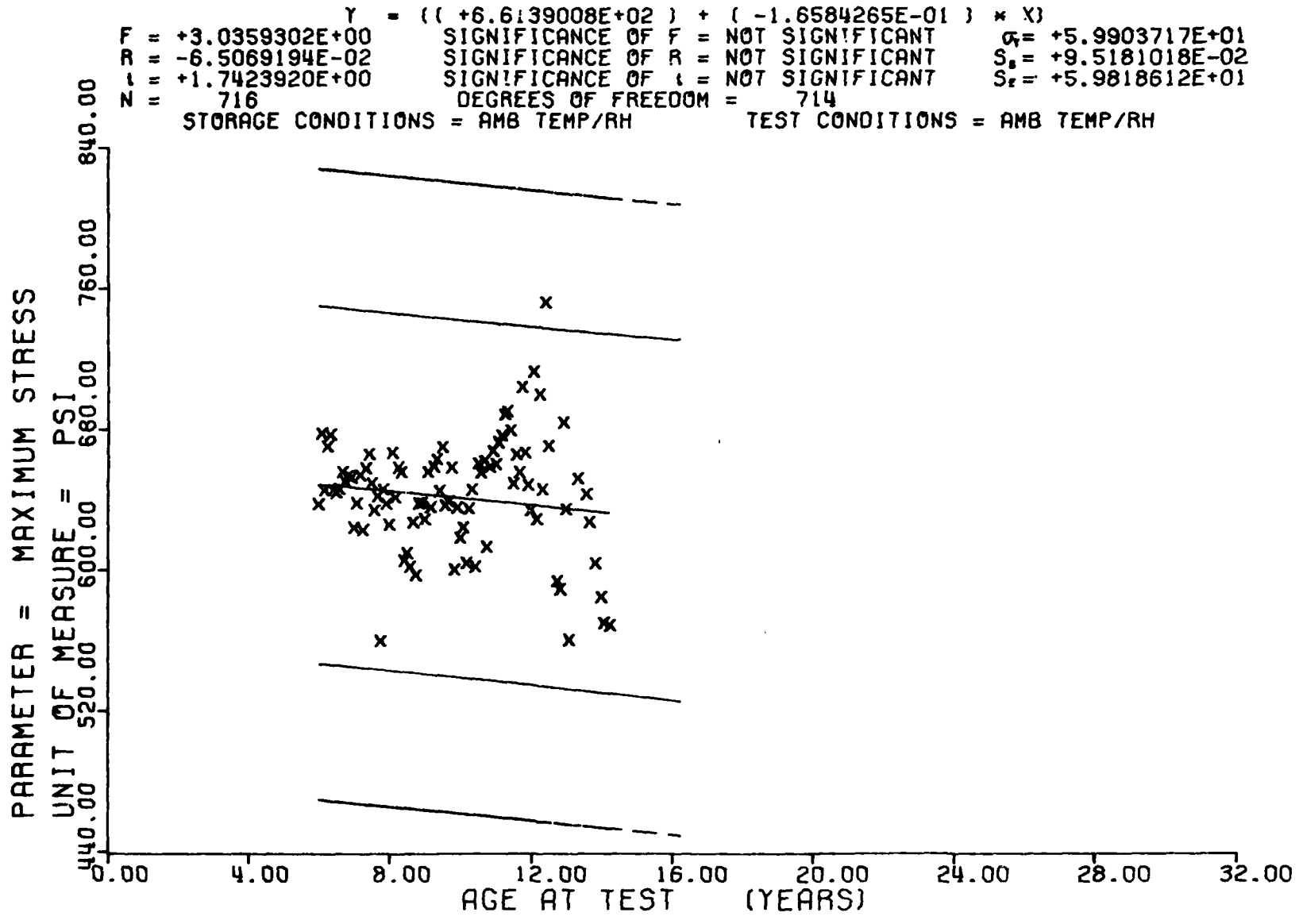
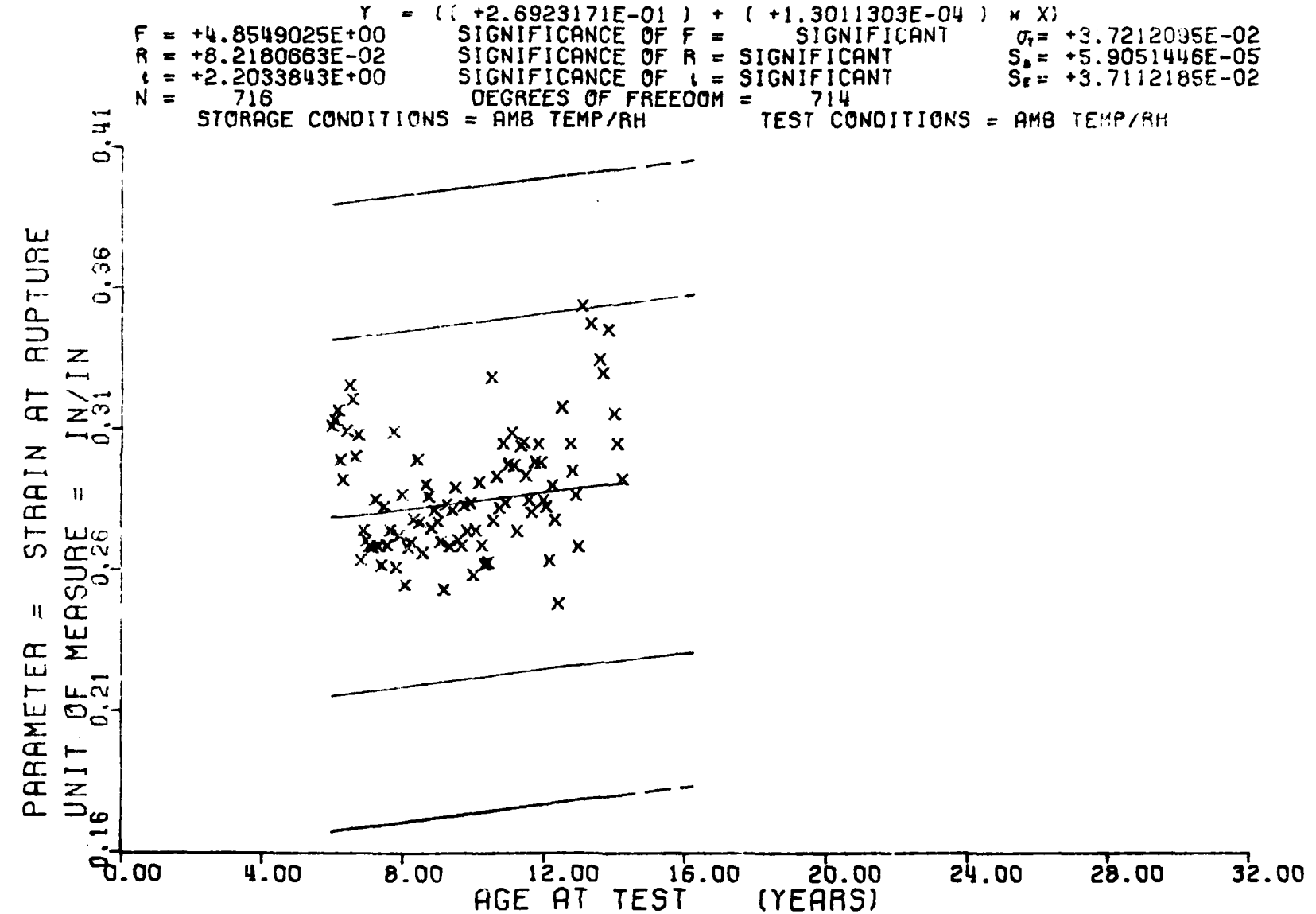
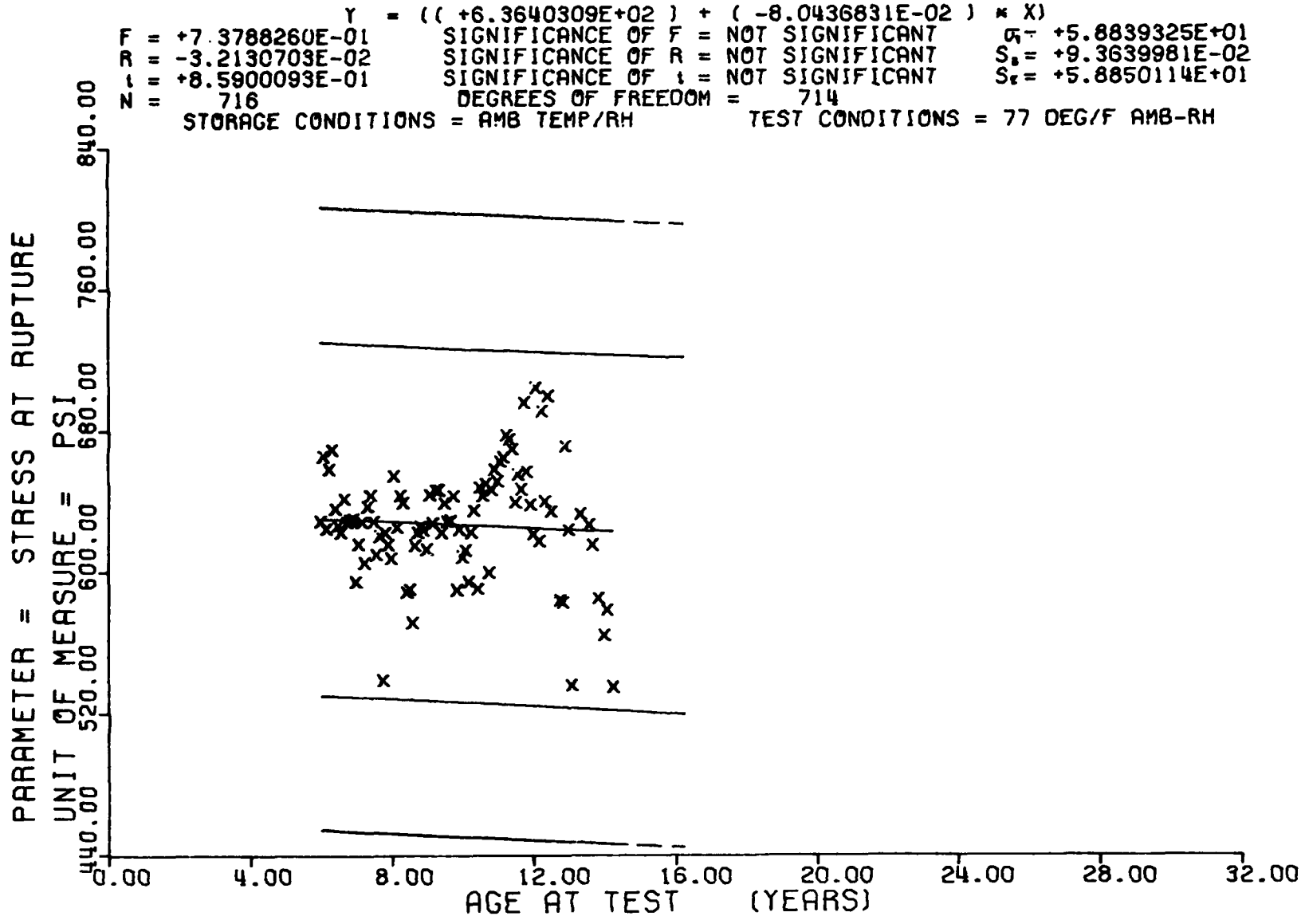

Y = ((+6.6139008E+02) + (-1.6584265E-01) * X)
F = +3.0359302E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σ_Y = +5.9903717E+01
R = -6.5069194E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT S_B = +9.5181018E-02
t = +1.7423920E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT S_E = +5.9818612E+01
N = 716 DEGREES OF FREEDOM = 714
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
840.00
760.00
680.00
600.00
520.00
440.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 142 H.R. TRIAXIAL CHS=1750,PSI=600, MAXIMUM STRESS (SM)

Figure 22



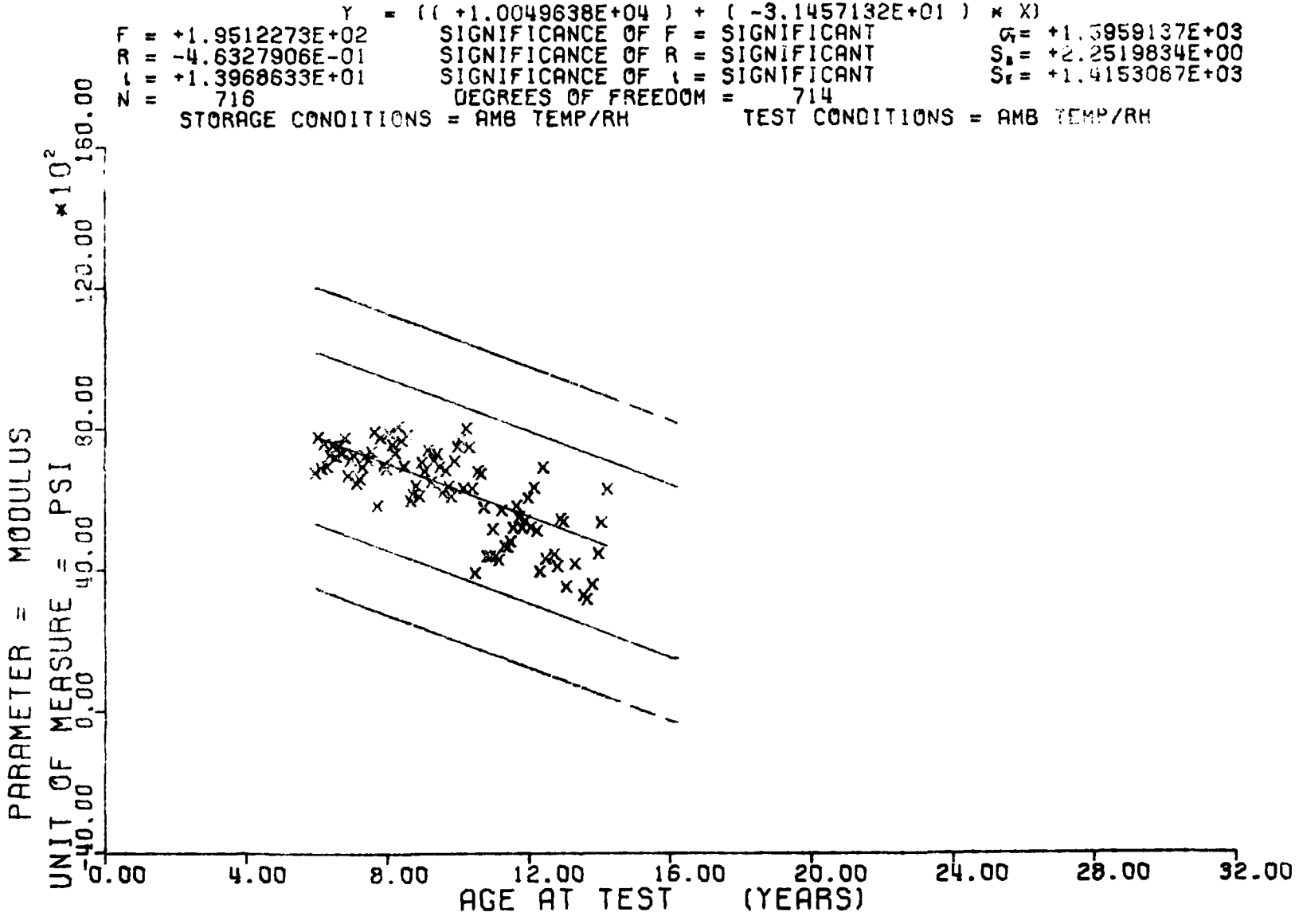
STAGE I.WING 142 H.R. TRIAXIAL CHS=1750,PSI=600, STRAIN AT RUPTURE (ER)

Figure 23



STAGE 1,WING 142 H.R. TRIAXIAL CHS=1750,PSI=600, STRESS AT RUPTURE (SR)

Figure 24



STAGE 1,WING 142 H.R. TRIAXIAL CHS=1750,PSI=600, MODULUS (E)

Figure 25

*** SAMPLE SIZE SUMMARY ***

AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES
7.0	4	32.0	39	64.0	9	89.0	66	114	33	139	27
8.0	3	33.0	38	65.0	12	90.0	72	115	36	140	18
9.0	5	34.0	30	66.0	12	91.0	113	116	20	141	33
10.0	4	35.0	29	67.0	24	92.0	63	117	35	142	15
11.0	5	36.0	28	68.0	6	93.0	93	118	21	144	3
12.0	7	37.0	23	69.0	17	94.0	60	119	36	145	3
13.0	6	38.0	20	70.0	27	95.0	39	120	42	147	6
14.0	10	39.0	15	71.0	24	96.0	30	121	15	152	3
15.0	12	40.0	28	72.0	24	97.0	23	122	9	153	24
16.0	9	41.0	38	73.0	21	98.0	30	123	12	154	15
17.0	6	42.0	84	74.0	21	99.0	15	124	27	155	9
18.0	8	43.0	63	75.0	21	100.0	48	125	21	156	3
19.0	7	44.0	50	76.0	30	101.0	36	126	44	157	60
20.0	11	45.0	39	77.0	15	102.0	27	127	51	158	3
21.0	12	46.0	48	78.0	27	103.0	43	128	21	159	54
22.0	9	47.0	36	79.0	27	104.0	34	129	33	160	9
23.0	8	48.0	15	80.0	30	105.0	27	130	18	162	3
24.0	8	49.0	17	81.0	18	106.0	33	131	27	163	3
25.0	18	50.0	5	82.0	36	107.0	24	132	28	164	3
26.0	13	51.0	4	83.0	27	108.0	33	133	18	165	6
27.0	17	52.0	3	84.0	27	109.0	27	134	33	166	9
28.0	17	53.0	5	85.0	33	110.0	21	135	36	168	6
29.0	29	58.0	3	86.0	33	111.0	18	136	39	183	3
30.0	29	62.0	3	87.0	69	112.0	36	137	33	191	3
31.0	50	63.0	3	88.0	69	113.0	21	138	15		

STAGE I.WING 1-2.STRESS RELAXATION 3.0% 1000 SEC TEST TEMP. 77 DEG

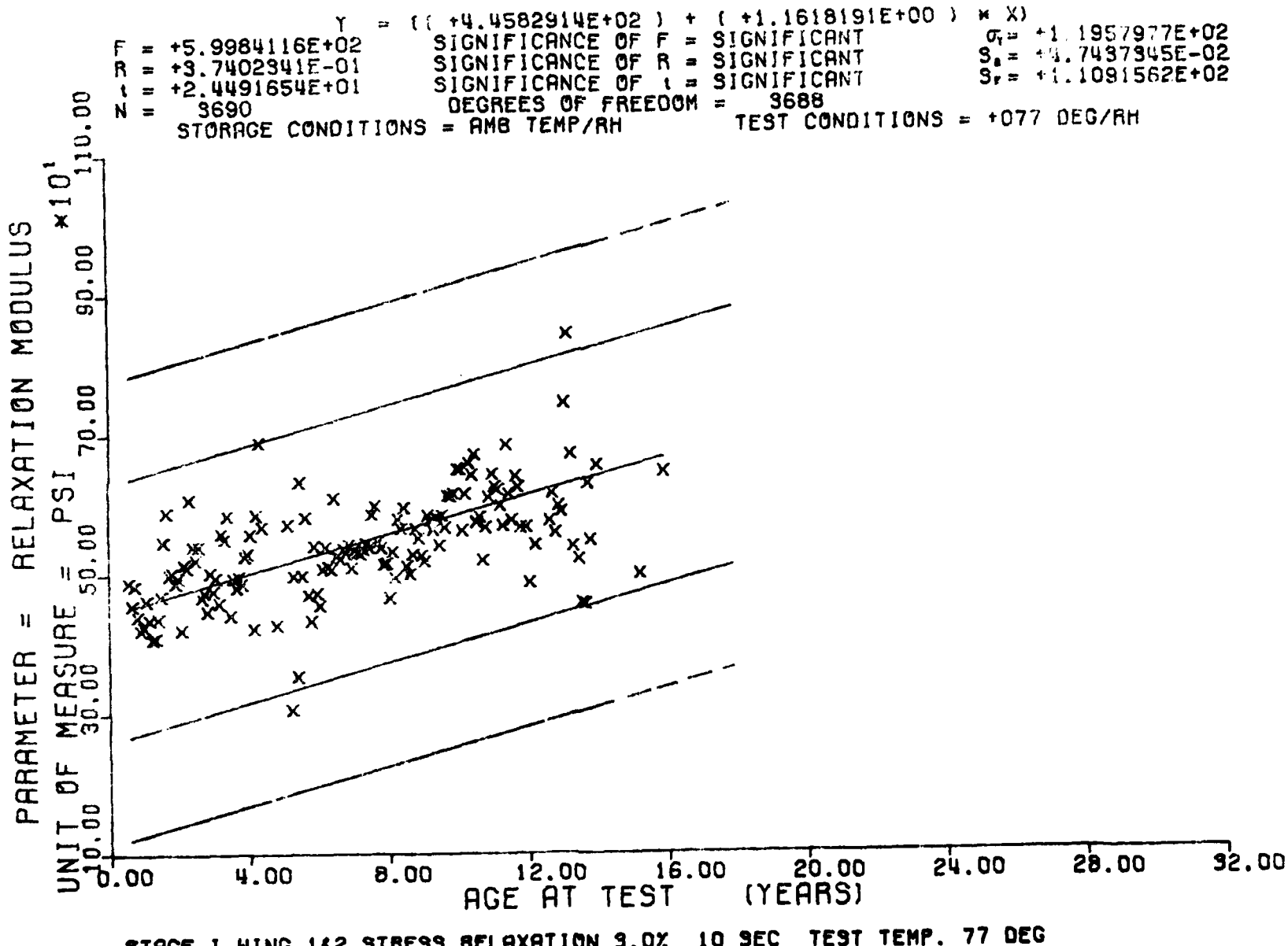
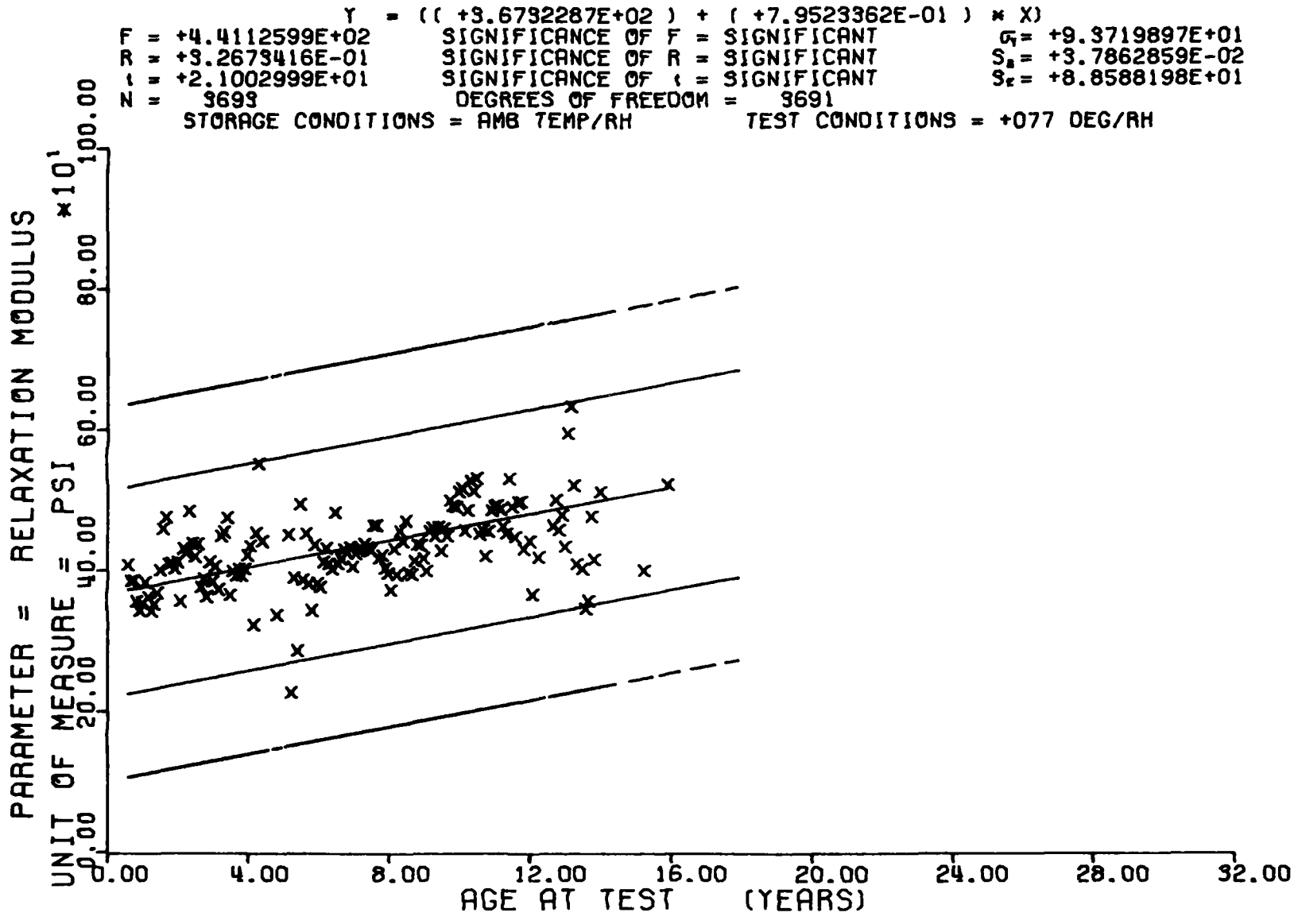

Y = ((+4.4582914E+02) + (+1.1618191E+00) * X)
F = +5.9984116E+02
SIGNIFICANCE OF F = SIGNIFICANT
σr = +1.1957977E+02
R = +3.7402341E-01
SIGNIFICANCE OF R = SIGNIFICANT
Sa = +4.7437345E-02
t = +2.4491654E+01
SIGNIFICANCE OF t = SIGNIFICANT
Sr = +1.1091562E+02
N = 3690
DEGREES OF FREEDOM = 3688
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = +077 DEG/RH
PARAMETER = RELAXATION MODULUS
UNIT OF MEASURE = PSI
*10¹
110.00
90.00
70.00
50.00
30.00
10.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE I,WING 142,STRESS RELAXATION 9.0% 10 SEC TEST TEMP. 77 DEG

Figure 26



STAGE I,WING 1&2,STRESS RELAXATION 9.0% 50 SEC TEST TEMP. 77 DEG

Figure 27

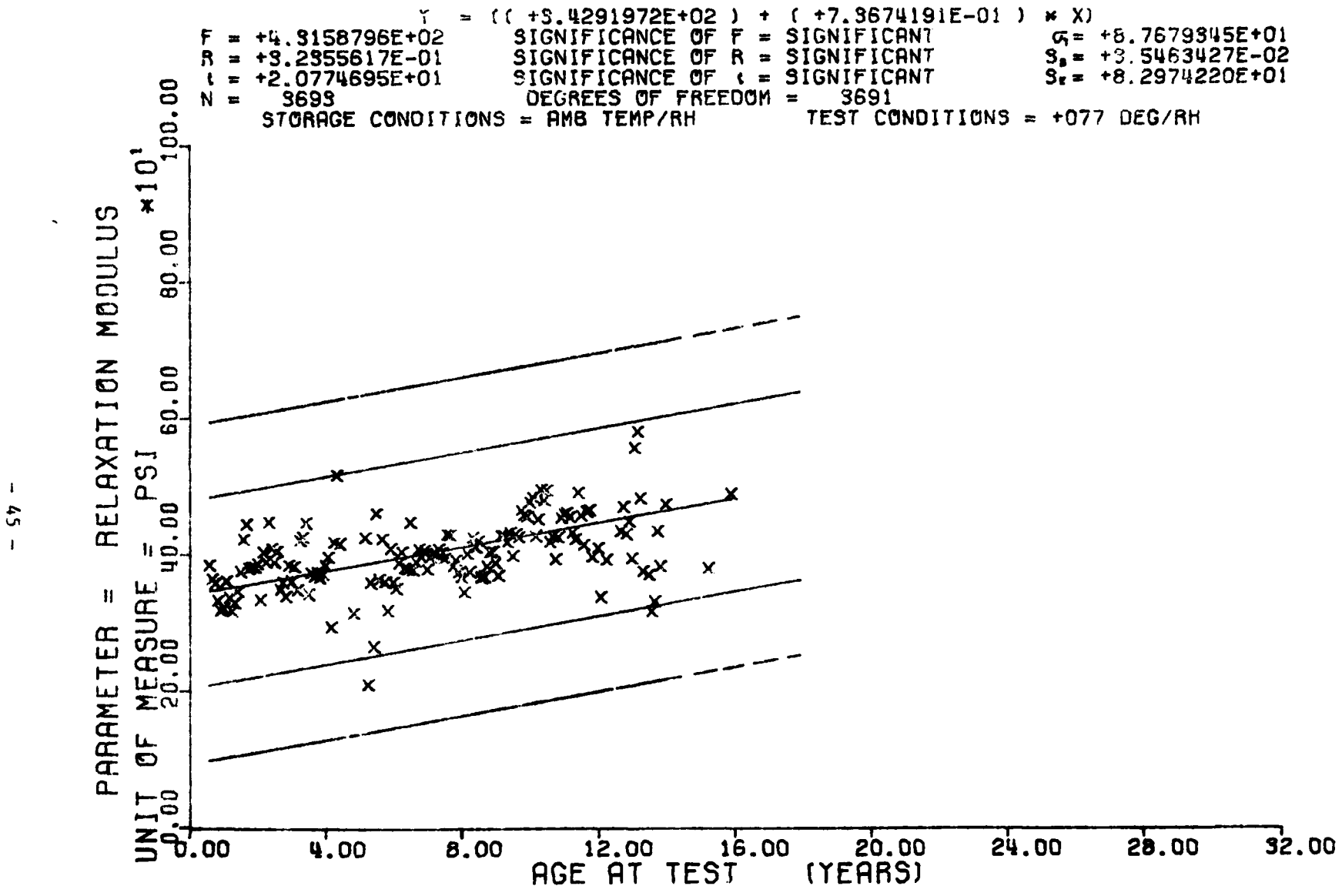

Y = ((+3.4291972E+02) + (+7.3674191E-01) * X)
F = +4.3158796E+02 SIGNIFICANCE OF F = SIGNIFICANT σ = +8.7679345E+01
R = +3.2355617E-01 SIGNIFICANCE OF R = SIGNIFICANT S_B = +3.5463427E-02
t = +2.0774695E+01 SIGNIFICANCE OF t = SIGNIFICANT S_E = +8.2974220E+01
N = 3693 DEGREES OF FREEDOM = 3691
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = +077 DEG/RH
PARAMETER = RELAXATION MODULUS
UNIT OF MEASURE = PSI *10¹
100.00
80.00
60.00
40.00
20.00
0.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE I.WING 142,STRESS RELAXATION 3.0% 100 SEC TEST TEMP. 77 DEG

Figure 28

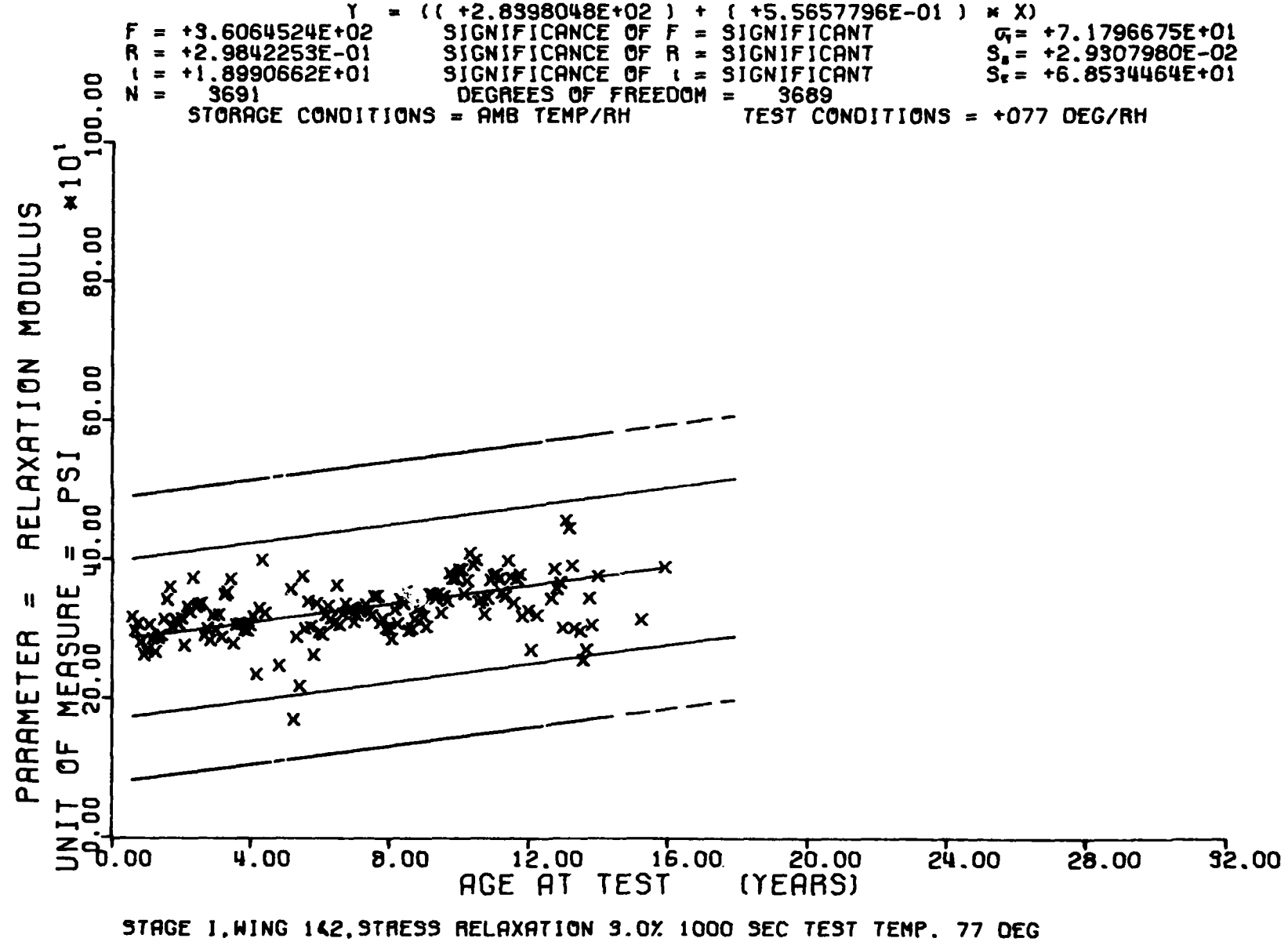

Y = ((+2.8398048E+02) + (+5.5657796E-01) * X)
F = +3.6064524E+02 SIGNIFICANCE OF F = SIGNIFICANT σ = +7.1796675E+01
R = +2.9842253E-01 SIGNIFICANCE OF R = SIGNIFICANT S = +2.9307980E-02
t = +1.8990662E+01 SIGNIFICANCE OF t = SIGNIFICANT S = +6.8534464E+01
N = 3691 DEGREES OF FREEDOM = 3689
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = +077 DEG/RH
PARAMETER = RELAXATION MODULUS
UNIT OF MEASURE = PSI *10¹
100.00
80.00
60.00
40.00
20.00
0.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 142,STRESS RELAXATION 3.0% 1000 SEC TEST TEMP. 77 DEG

Figure 29

*** SAMPLE SIZE SUMMARY ***

AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES
7.0	4	32.0	40	63.0	3	88.0	66	113	18	138	15
8.0	3	33.0	38	64.0	9	89.0	69	114	33	139	27
9.0	5	34.0	30	65.0	12	90.0	81	115	30	140	18
10.0	4	35.0	30	66.0	12	91.0	99	116	27	141	32
11.0	5	36.0	27	67.0	24	92.0	69	117	39	142	15
12.0	7	37.0	26	68.0	6	93.0	84	118	21	144	3
13.0	6	38.0	20	69.0	18	94.0	60	119	36	145	3
14.0	10	39.0	23	70.0	27	95.0	36	120	42	147	6
15.0	12	40.0	27	71.0	27	96.0	30	121	15	152	3
16.0	9	41.0	33	72.0	26	97.0	27	122	9	153	24
17.0	6	42.0	30	73.0	21	98.0	30	123	12	154	15
18.0	8	43.0	61	74.0	21	99.0	18	124	24	155	9
19.0	7	44.0	44	75.0	27	100.0	39	125	27	156	3
20.0	11	45.0	40	76.0	38	101.0	39	126	33	158	3
21.0	12	46.0	48	77.0	15	102.0	30	127	44	160	9
22.0	9	47.0	36	78.0	27	103.0	36	128	40	162	6
23.0	8	48.0	15	79.0	27	104.0	27	129	21	163	3
24.0	8	49.0	17	80.0	30	105.0	38	130	27	164	3
25.0	18	50.0	5	81.0	20	106.0	36	131	27	165	6
26.0	13	51.0	13	82.0	33	107.0	24	132	33	166	9
27.0	17	52.0	4	83.0	27	108.0	33	133	21	168	6
28.0	17	53.0	5	84.0	27	109.0	27	134	33	183	3
29.0	29	58.0	3	85.0	33	110.0	24	135	33	191	3
30.0	29	60.0	3	86.0	32	111.0	18	136	39		
31.0	51	62.0	3	87.0	69	112.0	36	137	27		

STAGE I,WING 1-2,STRESS RELAXATION 5.0% 1000 SEC TEST TEMP. 77 DEG

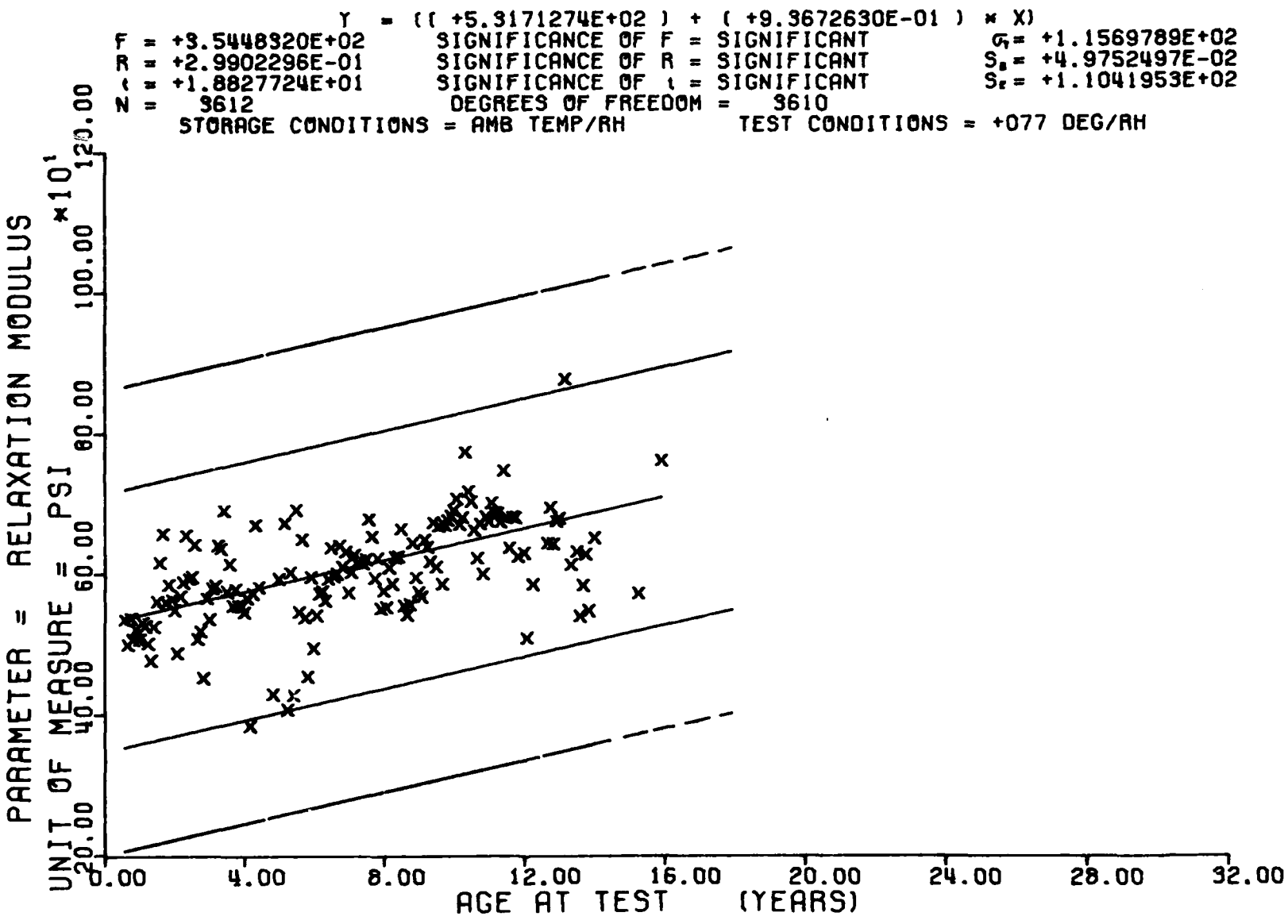

Y = ((+5.3171274E+02) + (+9.3672630E-01) * X)
F = +3.5448320E+02
R = +2.9902296E-01
ε = +1.8827724E+01
N = 3612
SIGNIFICANCE OF F = SIGNIFICANT
SIGNIFICANCE OF R = SIGNIFICANT
SIGNIFICANCE OF t = SIGNIFICANT
DEGREES OF FREEDOM = 3610
σt = +1.1569789E+02
Sa = +4.9752497E-02
Se = +1.1041953E+02
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = +077 DEG/RH
PARAMETER = RELAXATION MODULUS
UNIT OF MEASURE = PSI *10¹
120.00
100.00
80.00
60.00
40.00
20.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE I.WING 142.STRESS RELAXATION 5.0% 10 SEC TEST TEMP. 77 DEG

Figure 30

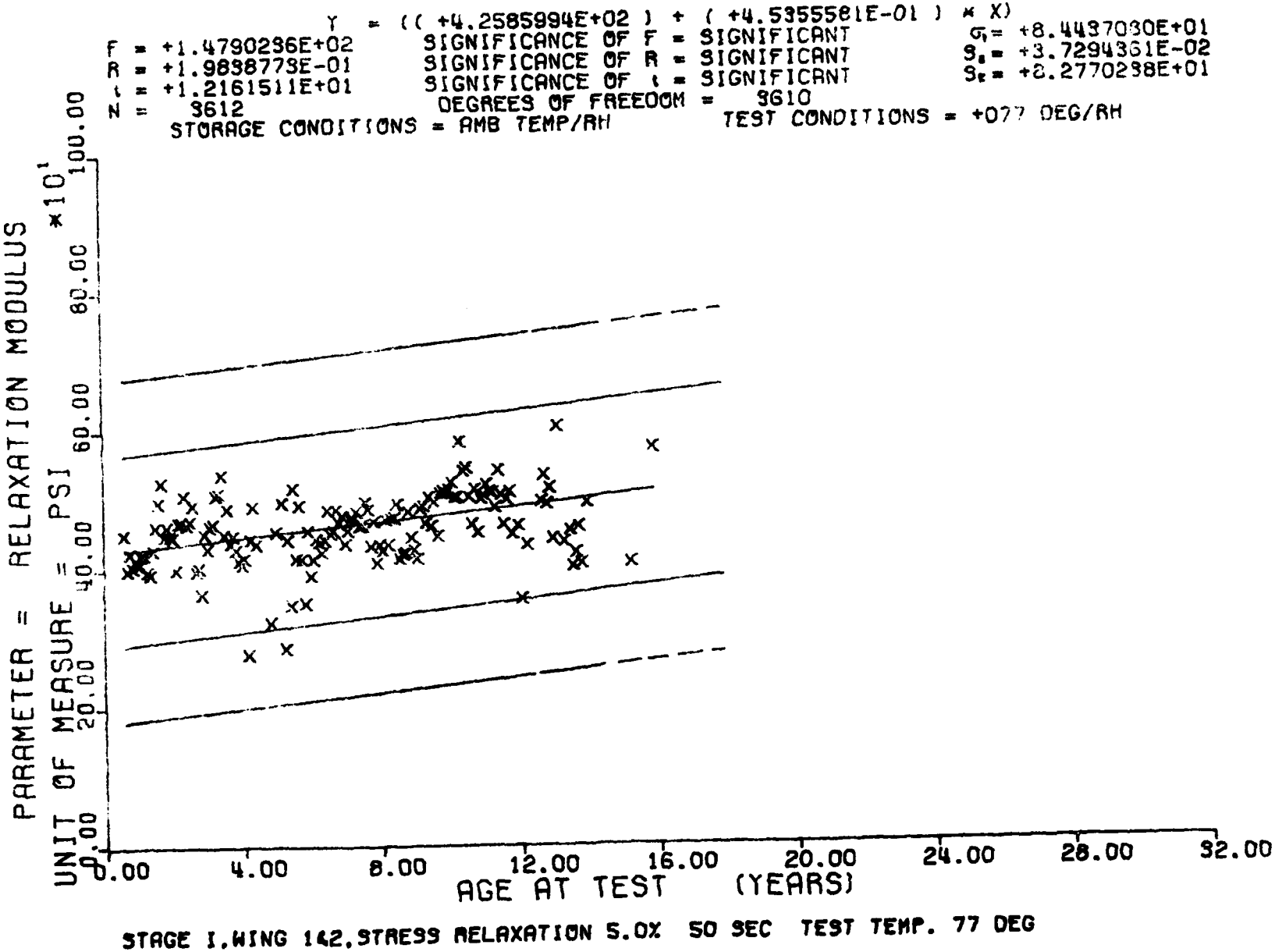

Y = ((+4.2585994E+02) + (+4.5355581E-01) * X)
F = +1.4790236E+02
SIGNIFICANCE OF F = SIGNIFICANT
σ1 = +8.4437030E+01
R = +1.9838773E-01
SIGNIFICANCE OF R = SIGNIFICANT
Sa = +3.7294361E-02
t = +1.2161511E+01
SIGNIFICANCE OF t = SIGNIFICANT
Se = +8.2770238E+01
N = 3612
DEGREES OF FREEDOM = 3610
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = +077 DEG/RH
PARAMETER = RELAXATION MODULUS
UNIT OF MEASURE = PSI
*10^1
100.00
80.00
60.00
40.00
20.00
0.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE I,WING 142,STRESS RELAXATION 5.0% 50 SEC TEST TEMP. 77 DEG

Figure 31

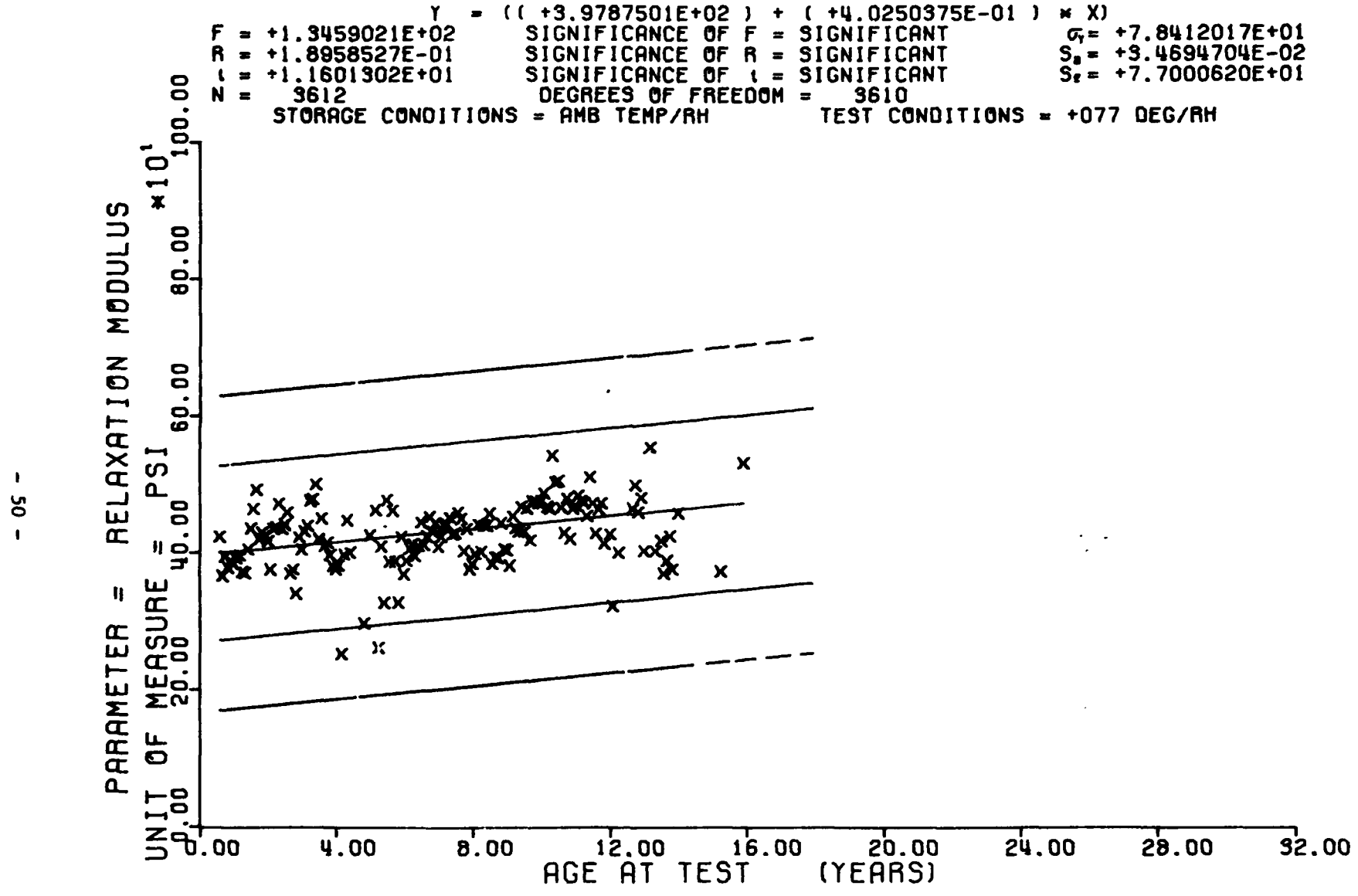
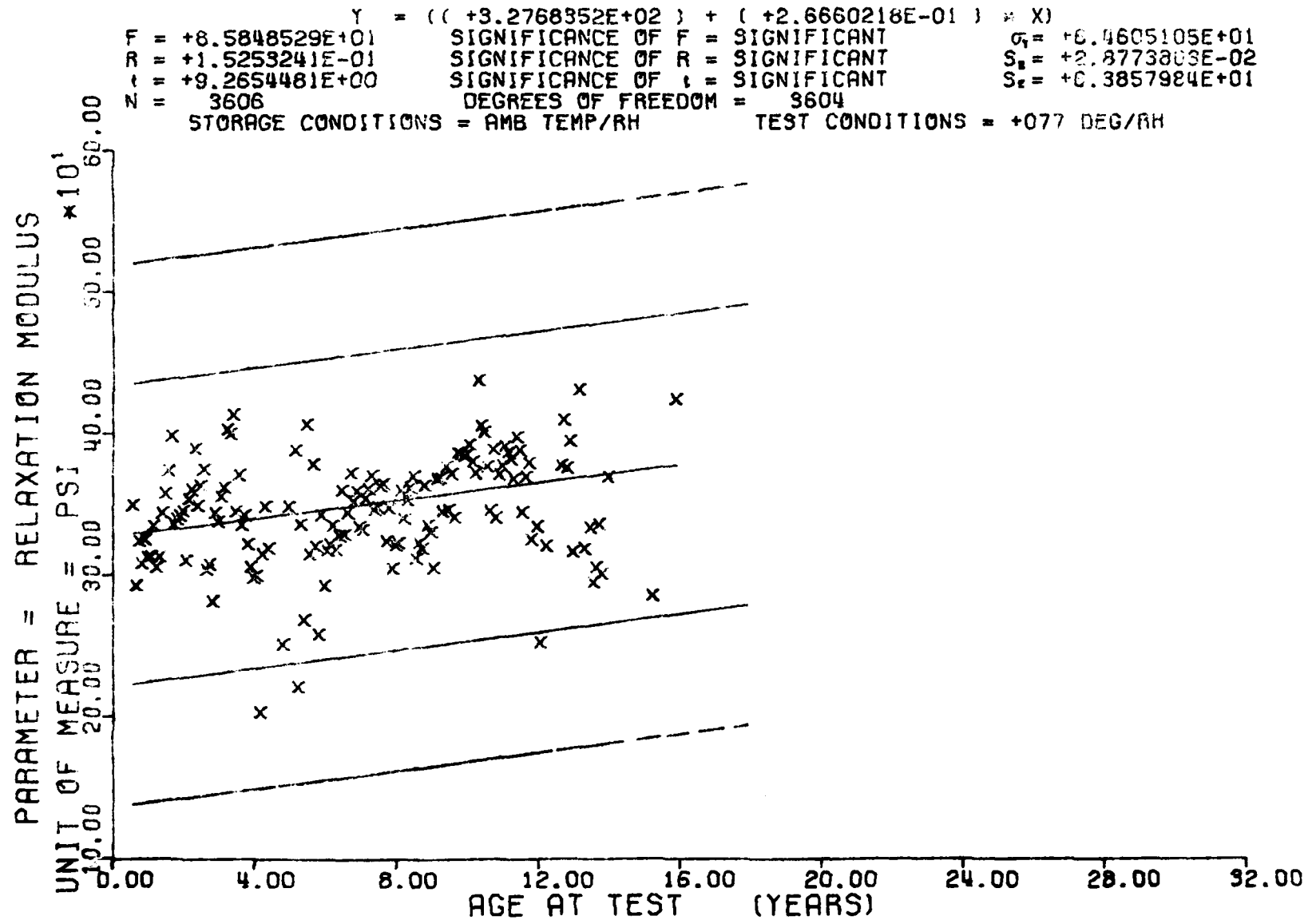

Y = ((+3.9787501E+02) + (+4.0250375E-01) * X)
F = +1.3459021E+02 SIGNIFICANCE OF F = SIGNIFICANT σ_Y = +7.8412017E+01
R = +1.8958527E-01 SIGNIFICANCE OF R = SIGNIFICANT S_a = +3.4694704E-02
t = +1.1601302E+01 SIGNIFICANCE OF t = SIGNIFICANT S_e = +7.7000620E+01
N = 3612 DEGREES OF FREEDOM = 3610
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = +077 DEG/RH
PARAMETER = RELAXATION MODULUS
UNIT OF MEASURE = PSI *10^1
0.00
20.00
40.00
60.00
80.00
100.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE I.WING 142.STRESS RELAXATION 5.0% 100 SEC TEST TEMP. 77 DEG

Figure 32



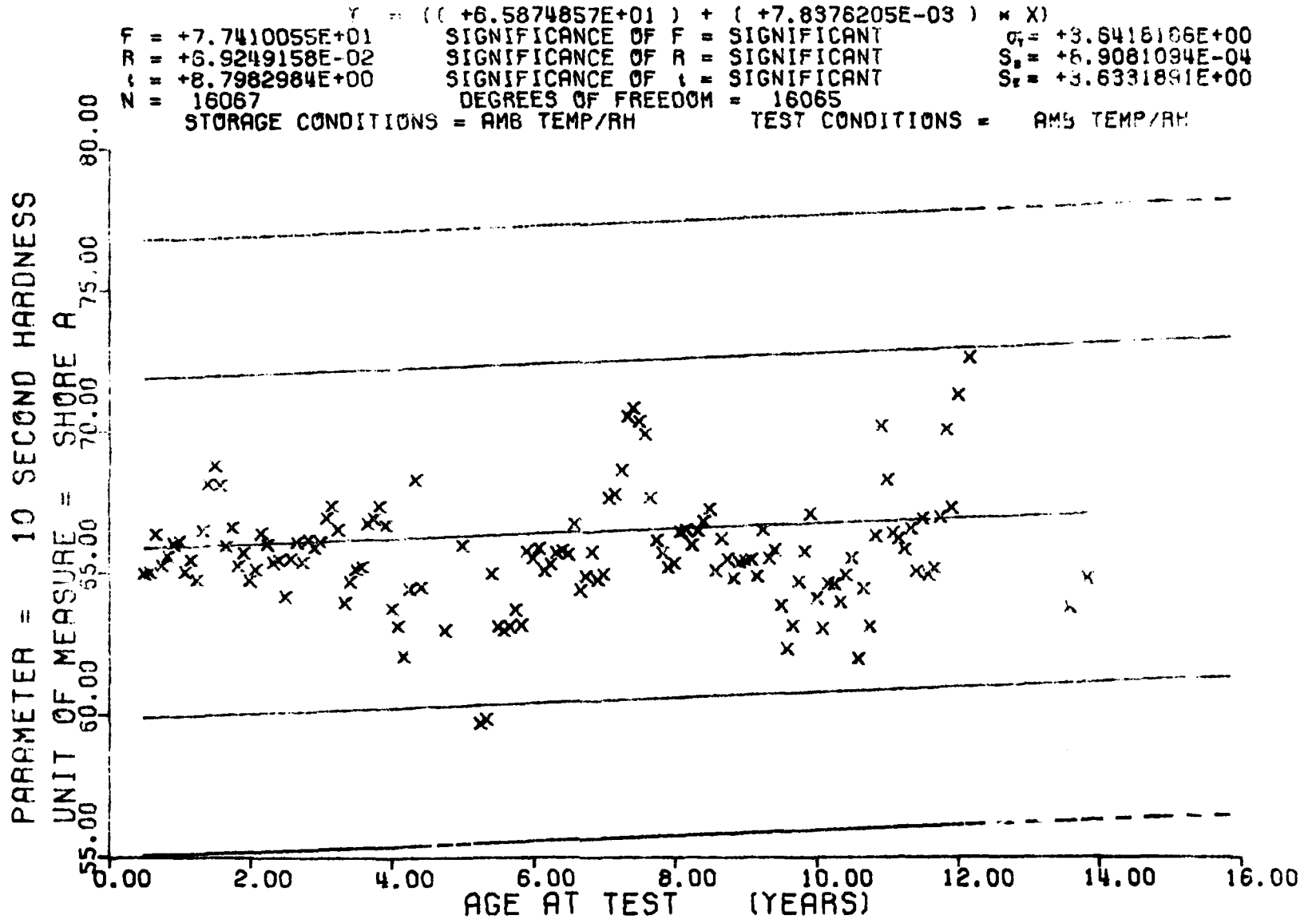
STAGE I,WING 142,STRESS RELAXATION 5.0% 1000 SEC TEST TEMP. 77 DEG

Figure 33

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES
6.0	3	31.0	150	63.0	18	88.0	525	113	138	138	27
7.0	24	32.0	63	64.0	24	89.0	585	114	153	139	27
8.0	74	33.0	90	65.0	3	90.0	610	115	87	140	15
9.0	30	34.0	72	66.0	30	91.0	466	116	102	141	6
10.0	28	35.0	74	67.0	6	92.0	528	117	78	142	9
11.0	38	36.0	99	68.0	21	93.0	302	118	143	143	6
12.0	40	37.0	61	69.0	35	94.0	346	119	121	144	3
13.0	75	38.0	77	70.0	22	95.0	191	120	120	146	3
14.0	95	39.0	68	71.0	87	96.0	180	121	15	163	33
15.0	105	40.0	49	72.0	78	97.0	180	122	72	166	6
16.0	25	41.0	99	73.0	63	98.0	183	123	42		
17.0	60	42.0	95	74.0	144	99.0	161	124	27		
18.0	57	43.0	174	75.0	102	100.0	198	125	42		
19.0	72	44.0	223	76.0	105	101.0	159	126	33		
20.0	57	45.0	234	77.0	114	102.0	171	127	33		
21.0	34	46.0	212	78.0	120	103.0	171	128	21		
22.0	73	47.0	234	79.0	117	104.0	195	129	27		
23.0	54	48.0	176	80.0	150	105.0	195	130	30		
24.0	87	49.0	138	81.0	168	106.0	213	131	24		
25.0	141	50.0	87	82.0	207	107.0	117	132	15		
26.0	218	51.0	57	83.0	190	108.0	207	133	9		
27.0	264	52.0	25	84.0	308	109.0	126	134	12		
28.0	257	53.0	26	85.0	180	110.0	156	135	24		
29.0	243	57.0	3	86.0	195	111.0	195	136	15		
30.0	224	60.0	3	87.0	552	112.0	171	137	12		

WING 1&2, HARDNESS SHORE A, 10 SECOND PROPELLANT



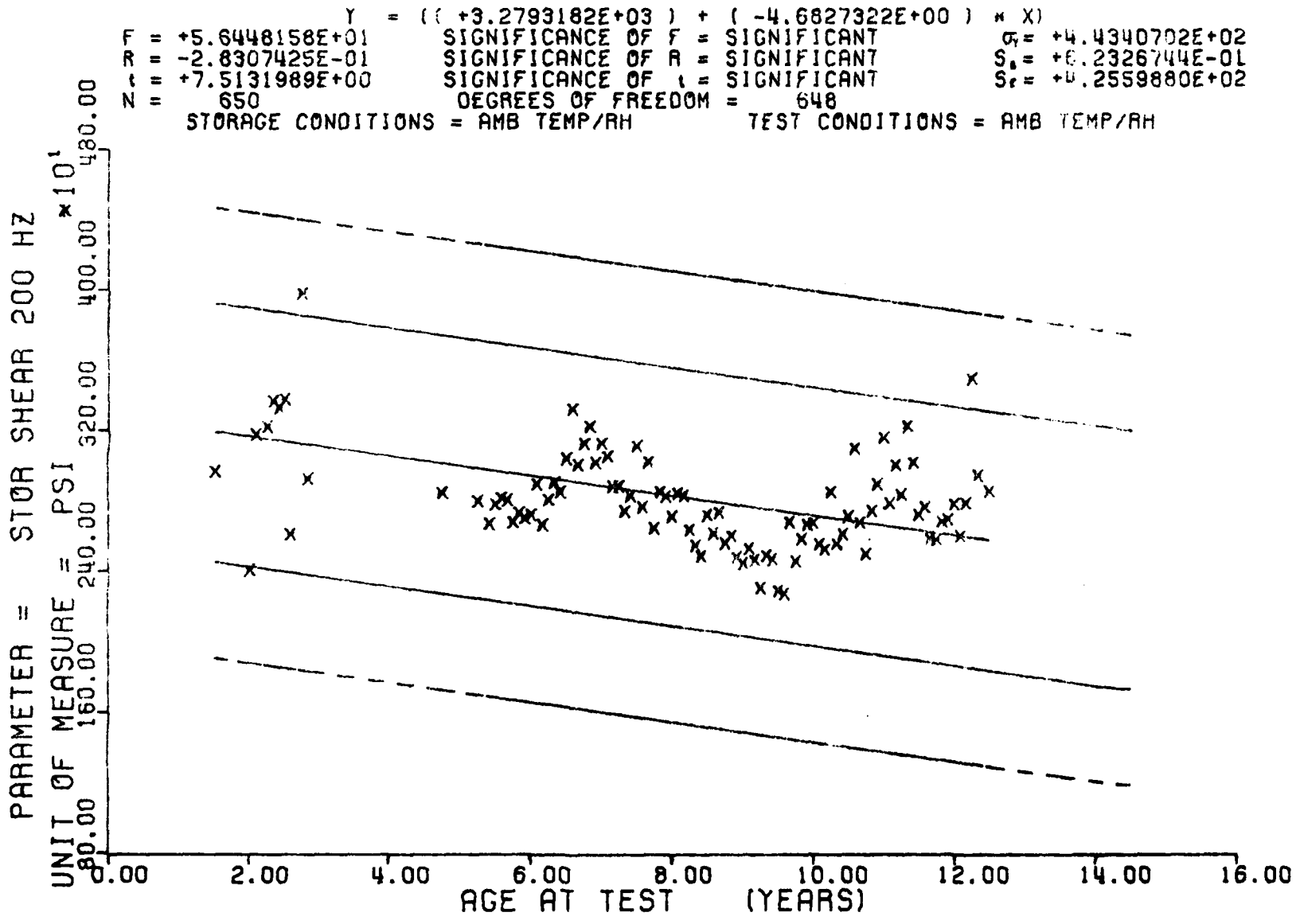
WING 142. HARDNESS SHORE A, 10 SECOND PROPELLANT

Figure 34

*** SAMPLE SIZE SUMMARY ***

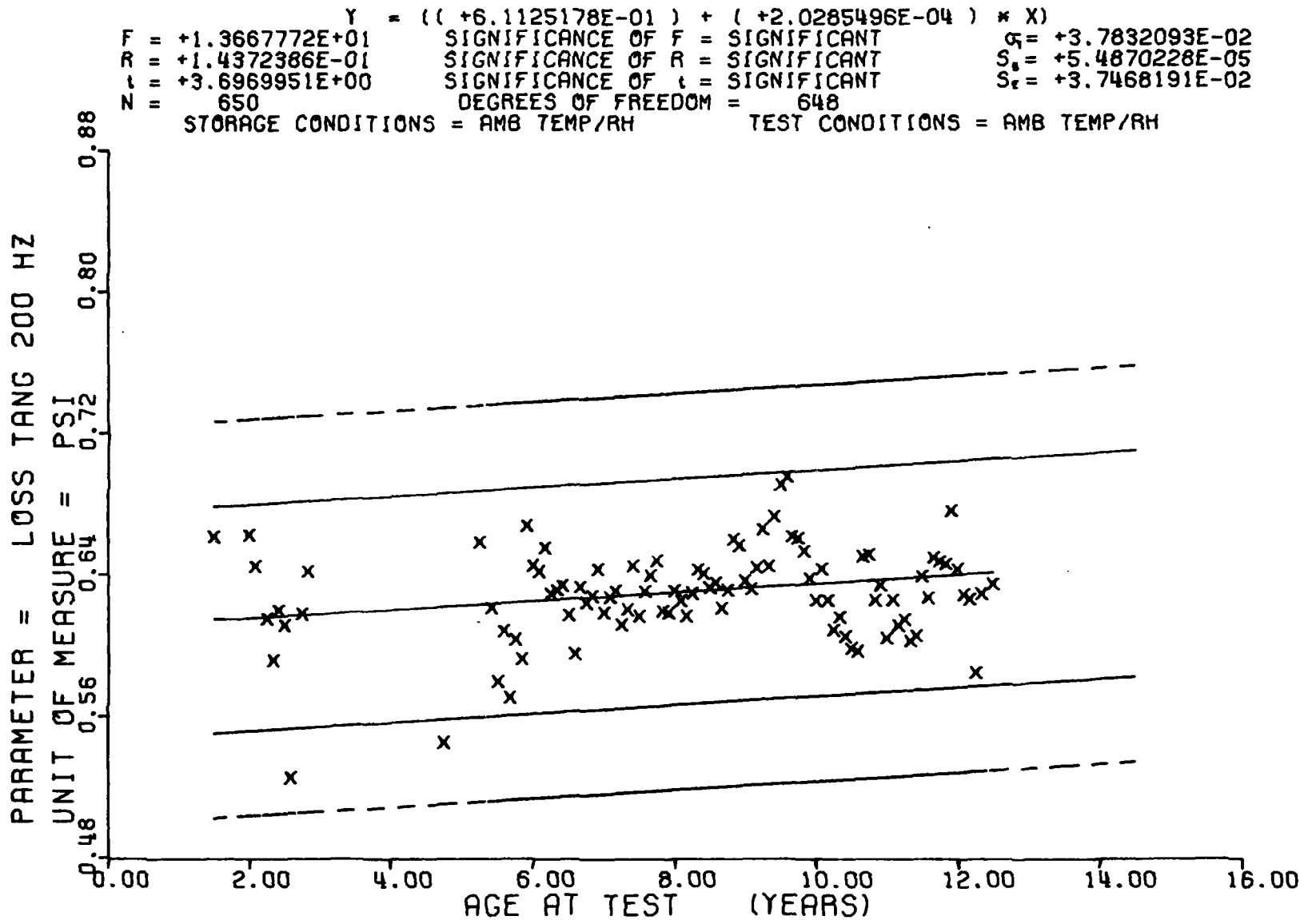
AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES
18.0	1	78.0	5	103.0	11	128.0	1
24.0	1	79.0	5	104.0	6	129.0	4
25.0	3	80.0	5	105.0	6	130.0	6
27.0	7	81.0	9	106.0	13	131.0	5
28.0	8	82.0	9	107.0	3	132.0	4
29.0	8	83.0	11	108.0	6	133.0	2
30.0	11	84.0	8	109.0	7	134.0	4
31.0	3	85.0	6	110.0	7	135.0	5
33.0	2	86.0	9	111.0	6	136.0	6
34.0	3	87.0	14	112.0	4	137.0	8
57.0	1	88.0	14	113.0	4	138.0	7
63.0	3	89.0	13	114.0	6	139.0	4
65.0	3	90.0	45	115.0	3	140.0	4
66.0	2	91.0	33	116.0	6	141.0	4
67.0	4	92.0	28	117.0	8	142.0	2
68.0	3	93.0	23	118.0	8	143.0	3
69.0	4	94.0	10	119.0	4	144.0	2
70.0	7	95.0	7	120.0	7	145.0	1
71.0	3	96.0	7	121.0	10	146.0	2
72.0	7	97.0	9	122.0	6	147.0	2
73.0	7	98.0	4	123.0	5	148.0	2
74.0	3	99.0	4	124.0	4	150.0	1
75.0	7	100.0	9	125.0	4		
76.0	9	101.0	7	126.0	5		
77.0	9	102.0	7	127.0	3		

WING 1-2 S1 TP/H1011 DYNAMIC RESPONSE,CENTER/WT 70 GM,STOR SHEAR AT 400 HZ



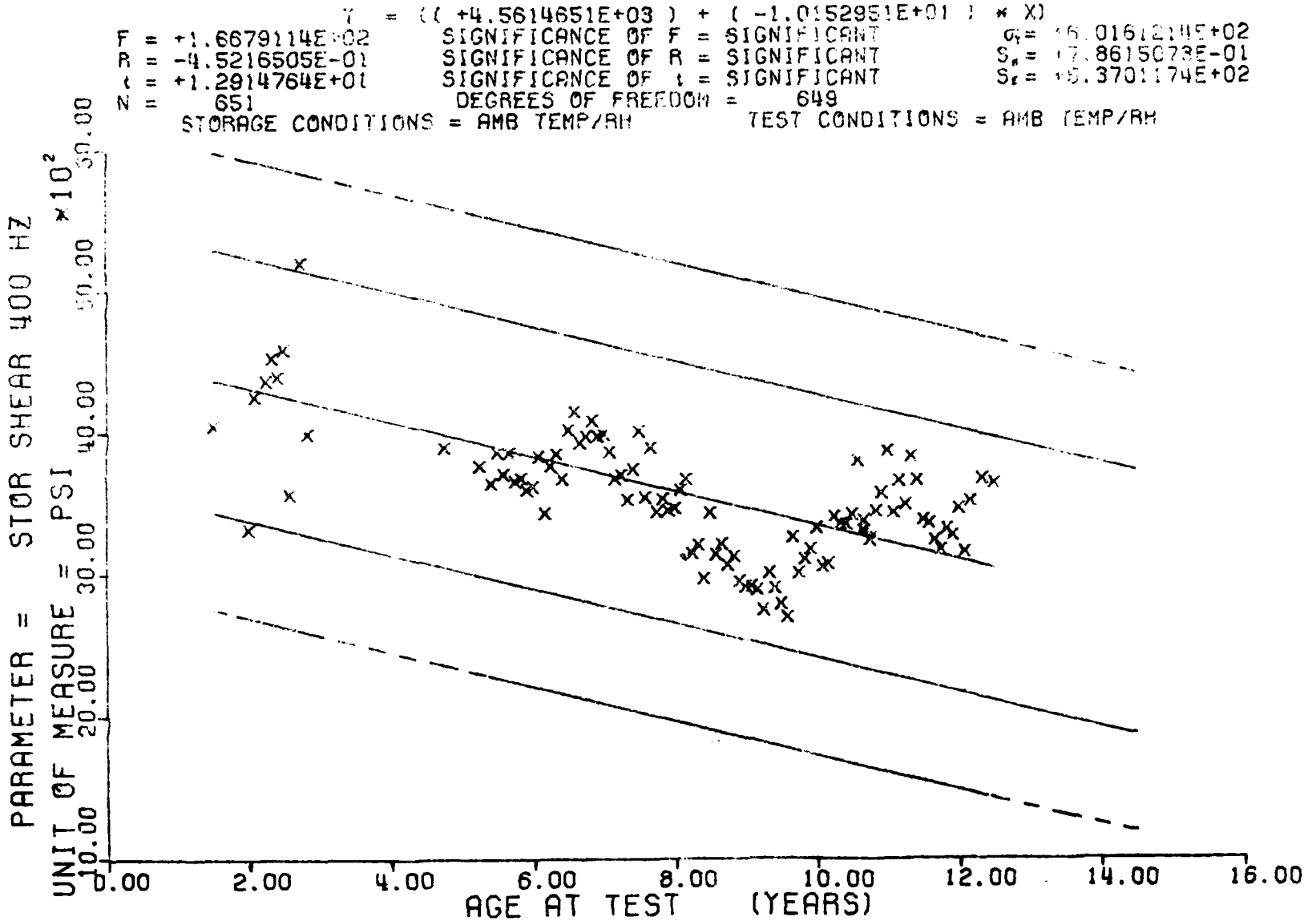
WING 142 S1 TP-H1011 DYNAMIC RESPONSE, CENTER-WT 70 GM, STOR SHEAR AT 200 HZ

Figure 35



51 WING 142 TP-H1011 DYNAMIC RESPONSE LOSS TANGENT AT 200 HZ,CENTER-WT 70 GM

Figure 36



WING 142 S1 TP-H1011 DYNAMIC RESPONSE, CENTER-WT 70 GM, STOR SHEAR AT 400 HZ

Figure 37

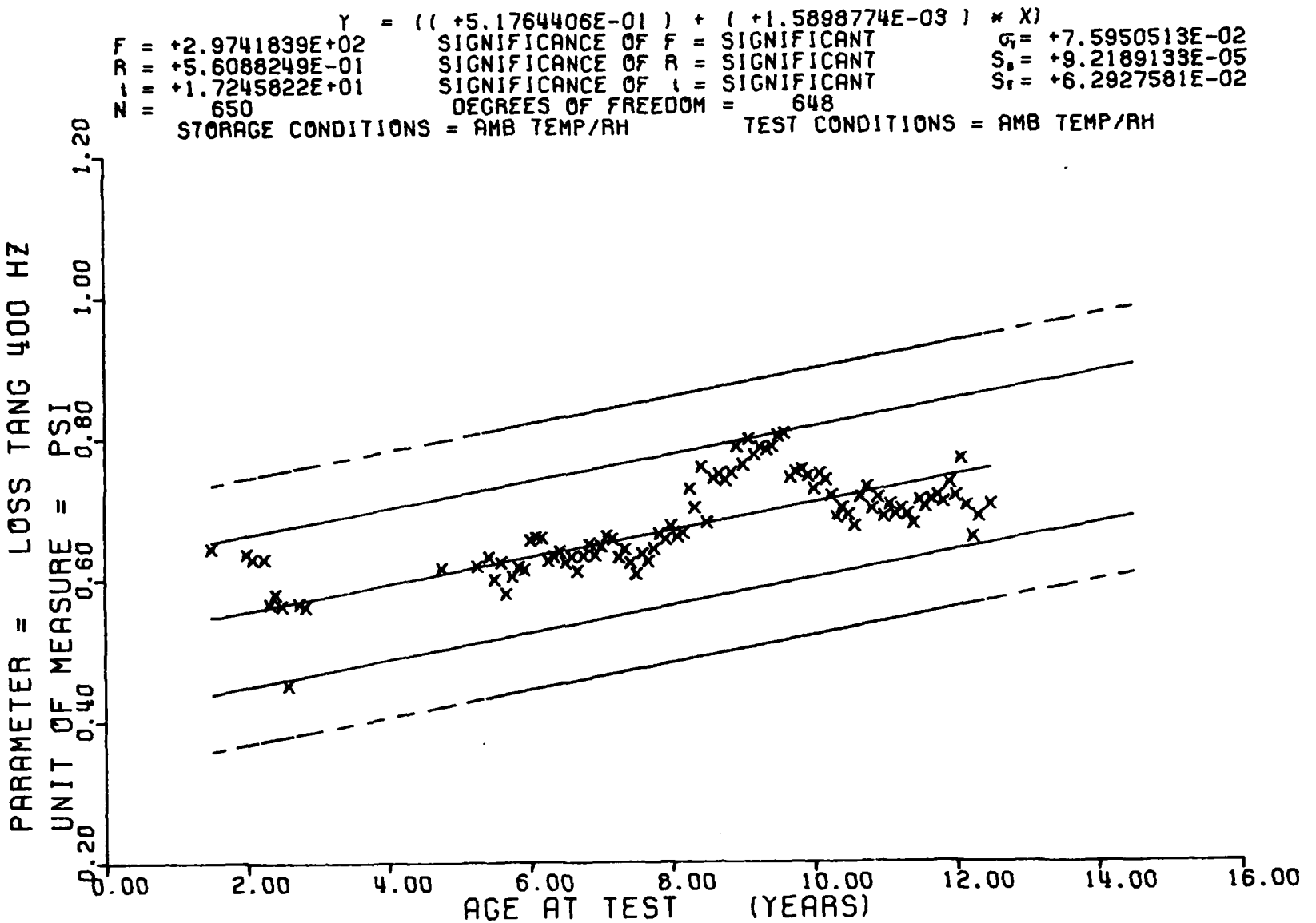

Y = ((+5.1764406E-01) + (+1.5898774E-03) * X)
F = +2.9741839E+02 SIGNIFICANCE OF F = SIGNIFICANT σ1 = +7.5950513E-02
R = +5.6088249E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +9.2189133E-05
t = +1.7245822E+01 SIGNIFICANCE OF t = SIGNIFICANT Sr = +6.2927581E-02
N = 650 DEGREES OF FREEDOM = 648
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = LOSS TANG 400 HZ
UNIT OF MEASURE = PSI
0.20
0.40
0.60
0.80
1.00
1.20
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
AGE AT TEST (YEARS)
S1 WING 142 TP-H1011 DYNAMIC RESPONSE LOSS TANGENT AT 400 HZ,CENTER-WT 70 GM

Figure 38

*** SAMPLE SIZE SUMMARY ***

AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES
2.0	1	31.0	24	56.0	1	88.0	19	113	30
7.0	1	32.0	18	64.0	2	89.0	24	114	15
8.0	3	33.0	14	65.0	1	90.0	11	115	18
9.0	3	34.0	9	66.0	3	91.0	9	116	21
10.0	5	35.0	9	67.0	3	92.0	47	117	15
11.0	3	36.0	5	68.0	8	93.0	25	118	18
12.0	3	37.0	9	69.0	2	94.0	30	119	33
13.0	5	38.0	3	70.0	6	95.0	50	120	21
14.0	9	39.0	9	71.0	4	96.0	60	121	18
15.0	15	40.0	5	72.0	6	97.0	37	122	12
16.0	13	41.0	8	73.0	1	98.0	34	123	6
17.0	4	42.0	5	74.0	6	99.0	45	124	6
18.0	14	43.0	12	75.0	4	100.0	35	125	3
19.0	6	44.0	11	76.0	5	101.0	25		
20.0	10	45.0	27	77.0	5	102.0	19		
21.0	10	46.0	28	78.0	4	103.0	48		
22.0	12	47.0	30	79.0	4	104.0	12		
23.0	11	48.0	26	80.0	7	105.0	33		
24.0	8	49.0	21	81.0	6	106.0	21		
25.0	16	50.0	18	82.0	7	107.0	22		
26.0	24	51.0	14	83.0	10	108.0	12		
27.0	28	52.0	7	84.0	2	109.0	21		
28.0	21	53.0	2	85.0	12	110.0	15		
29.0	28	54.0	3	86.0	11	111.0	6		
30.0	27	55.0	3	87.0	5	112.0	18		

STAGE 1 WING 1-2 TP/H1011 CONSTANT STRAIN

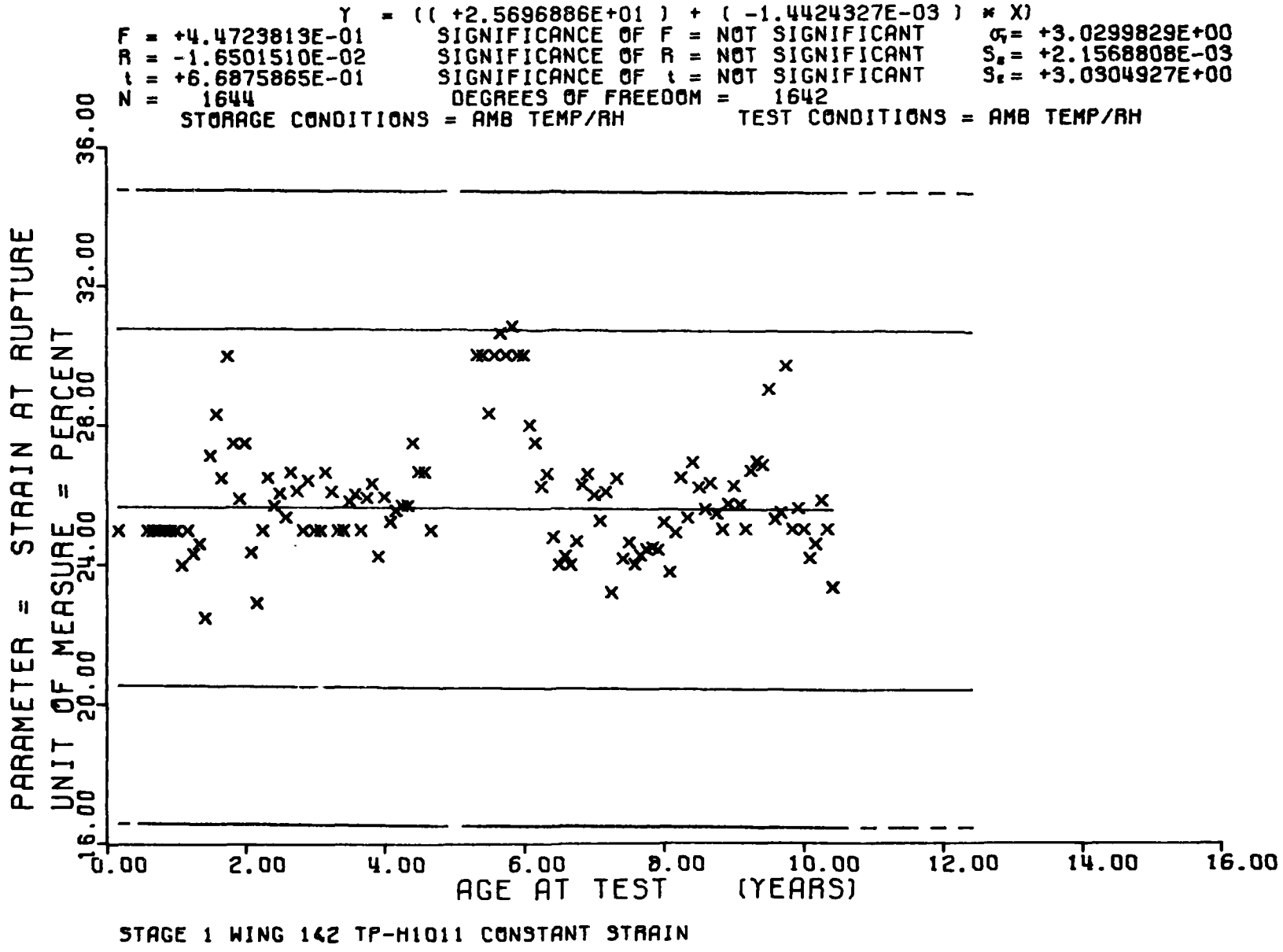

Y = ((+2.5696886E+01) + (-1.4424327E-03) * X)
F = +4.4723813E-01 SIGNIFICANCE OF F = NOT SIGNIFICANT σ = +3.0299829E+00
R = -1.6501510E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT S = +2.1568808E-03
t = +6.6875865E-01 SIGNIFICANCE OF t = NOT SIGNIFICANT S = +3.0304927E+00
N = 1644 DEGREES OF FREEDOM = 1642
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = PERCENT
36.00
32.00
28.00
24.00
20.00
16.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
AGE AT TEST (YEARS)
STAGE 1 WING 142 TP-H1011 CONSTANT STRAIN

Figure 39

*** SAMPLE SIZE SUMMARY ***

AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES
88.0	3	117.0	19	142.0	24
91.0	3	118.0	24	143.0	33
92.0	3	119.0	43	144.0	18
93.0	9	120.0	29	145.0	15
94.0	9	121.0	20	146.0	3
95.0	3	122.0	15	147.0	33
97.0	3	123.0	13	148.0	3
98.0	3	124.0	18	150.0	3
99.0	9	125.0	9	152.0	16
101.0	9	126.0	21	153.0	4
102.0	6	127.0	18	155.0	3
103.0	21	128.0	24	158.0	19
104.0	9	129.0	30	159.0	14
105.0	9	130.0	30	161.0	6
106.0	9	131.0	24	164.0	6
107.0	24	132.0	9	165.0	3
108.0	12	133.0	12	167.0	6
109.0	24	134.0	24	169.0	6
110.0	3	135.0	12		
111.0	9	136.0	24		
112.0	3	137.0	21		
113.0	24	138.0	30		
114.0	9	139.0	41		
115.0	21	140.0	9		
116.0	18	141.0	24		

WING 1-2 STAGE 1 TP/H1011 THERMAL COEFFICIENT OF LINEAR EXPANSION BELOW TG

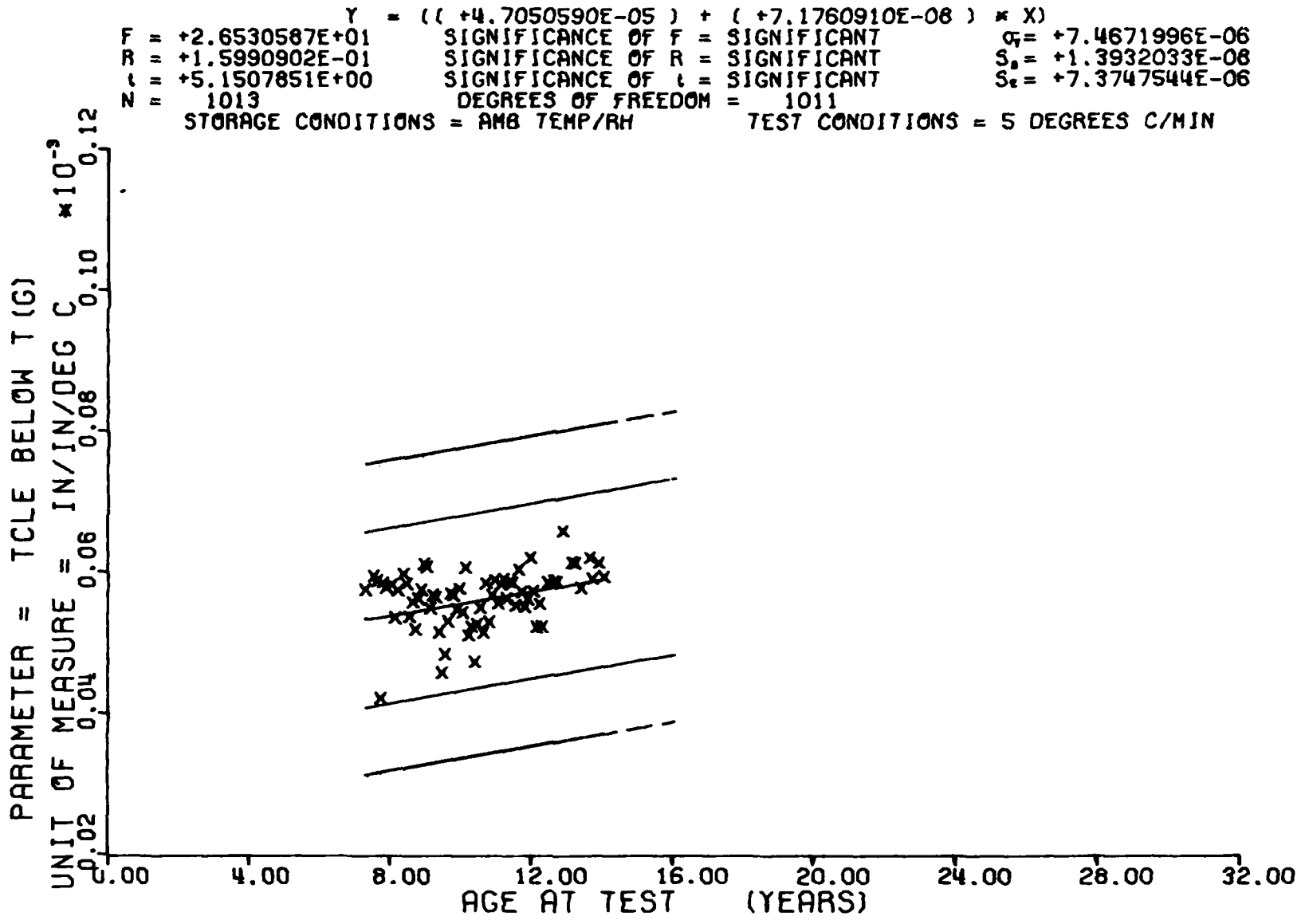
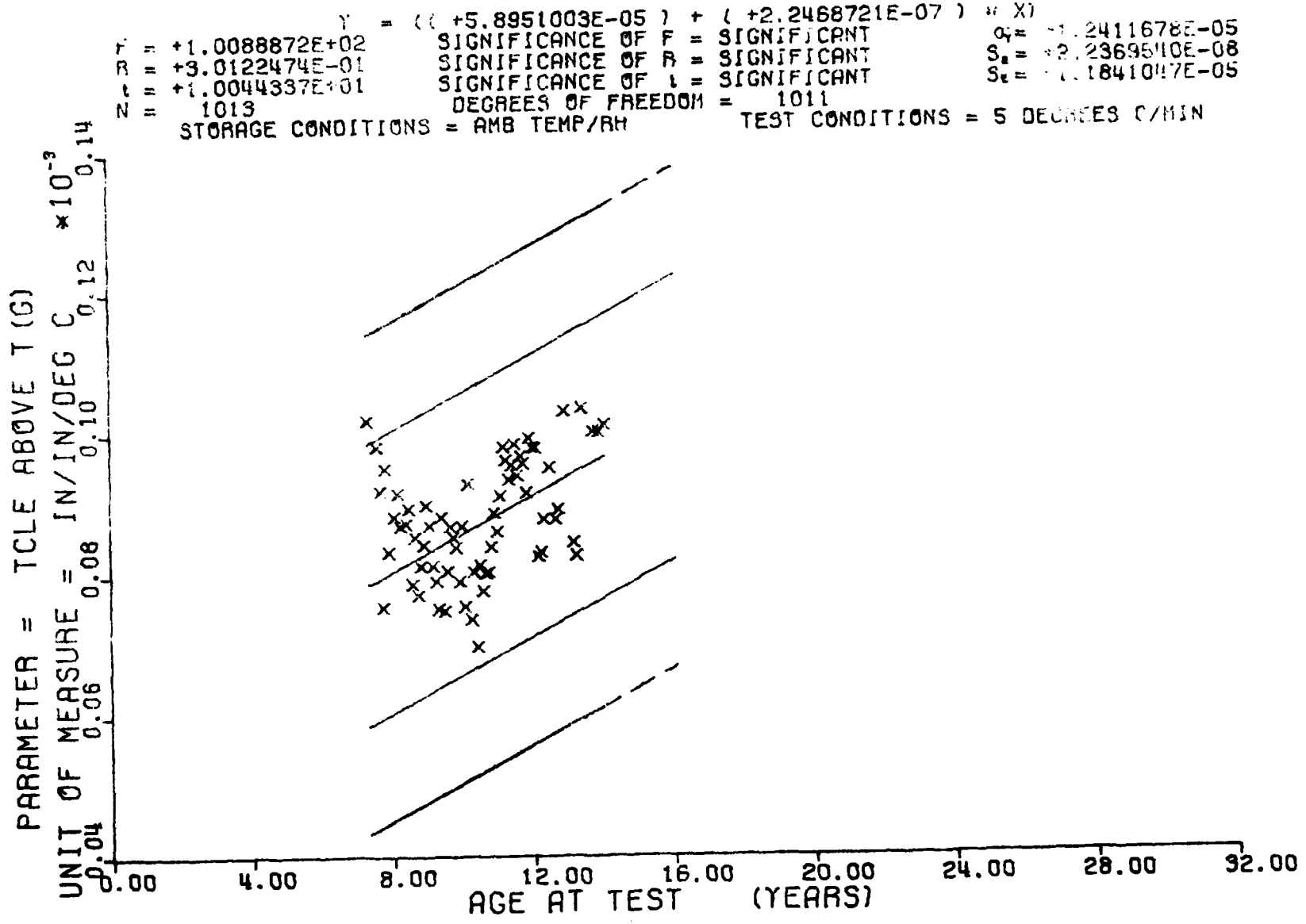

Y = ((+4.7050590E-05) + (+7.1760910E-08) * X)
F = +2.6530587E+01 SIGNIFICANCE OF F = SIGNIFICANT σr= +7.4671996E-06
R = +1.5990902E-01 SIGNIFICANCE OF R = SIGNIFICANT Sa= +1.3932033E-08
t = +5.1507851E+00 SIGNIFICANCE OF t = SIGNIFICANT St= +7.3747544E-06
N = 1013 DEGREES OF FREEDOM = 1011
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = 5 DEGREES C/MIN
PARAMETER = TCLE BELOW T(G)
UNIT OF MEASURE = IN/IN/DEG C *10-3
0.12
0.10
0.08
0.06
0.04
0.02
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
WING 1&2 STAGE 1 TP-H1011 THERMAL COEFFICIENT OF LINEAR EXPANSION BELOW TG

Figure 40



WING 1&2 STAGE 1 TP-H1011, THERMAL COEFFICIENT OF LINEAR EXPANSION ABOVE TG

Figure 41

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
62.0	4	91.0	72	126.0	28	155.0	16
63.0	8	92.0	103	127.0	45	160.0	30
66.0	4	93.0	108	128.0	24		
67.0	8	94.0	130	129.0	21		
68.0	12	95.0	84	130.0	8		
70.0	4	96.0	59	131.0	20		
71.0	4	97.0	19	132.0	16		
72.0	3	98.0	24	133.0	12		
74.0	36	99.0	12	134.0	4		
75.0	8	110.0	28	135.0	8		
76.0	16	111.0	40	136.0	36		
77.0	20	112.0	32	137.0	32		
78.0	36	113.0	15	138.0	20		
79.0	20	114.0	36	139.0	28		
80.0	36	115.0	16	140.0	40		
81.0	56	116.0	24	141.0	28		
82.0	40	117.0	8	142.0	52		
83.0	24	118.0	16	143.0	40		
84.0	24	119.0	16	144.0	12		
85.0	24	120.0	28	145.0	12		
86.0	32	121.0	20	146.0	12		
87.0	20	122.0	56	147.0	4		
88.0	4	123.0	40	148.0	4		
89.0	72	124.0	28	149.0	27		
90.0	68	125.0	48	154.0	24		

STAGE 1 WING 1&2 TP-H1011 SOL GEL CROSSLINK DENSITY

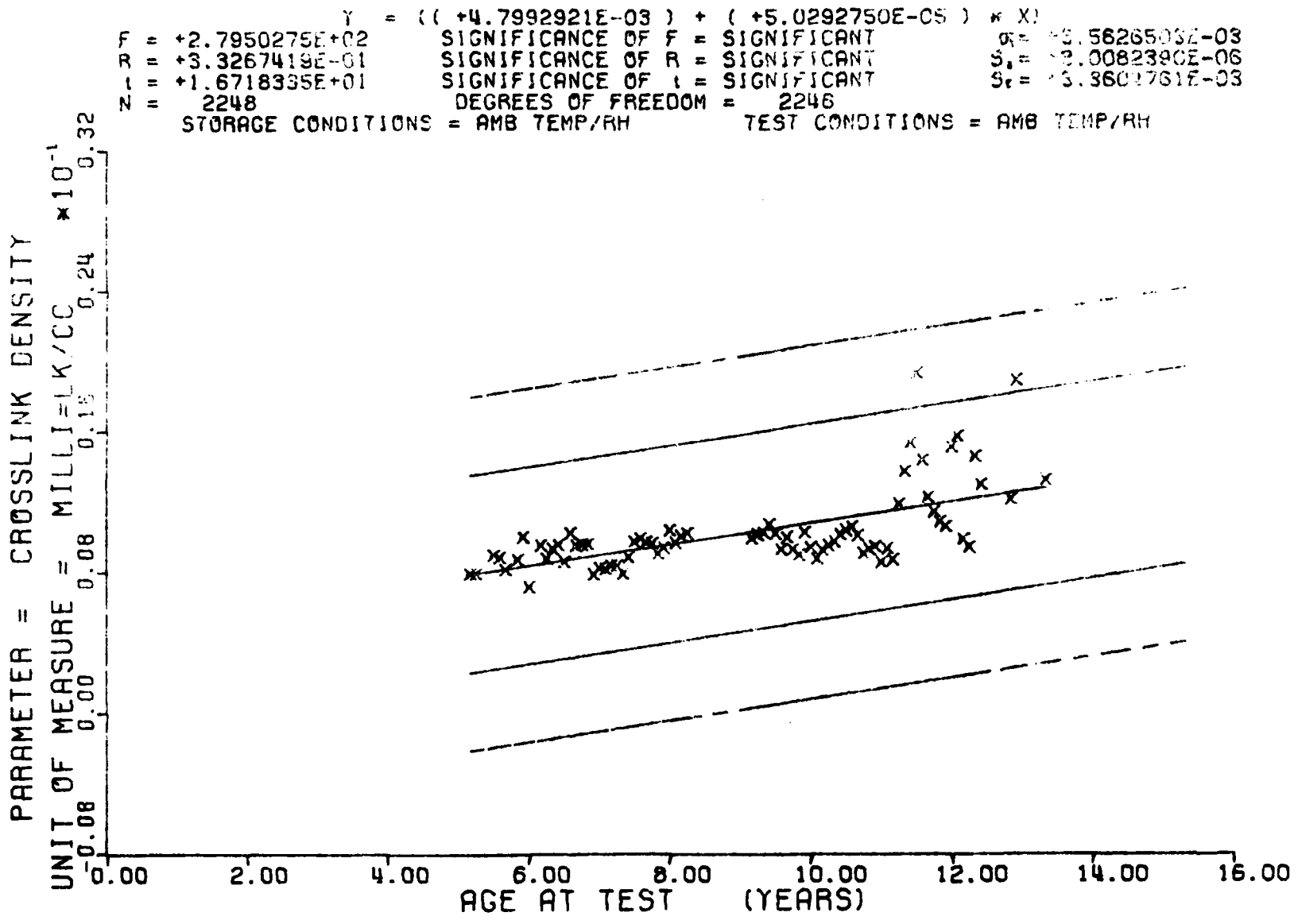

Y = ((+4.7992921E-03) + (+5.0292750E-05) * X)
F = +2.7950275E+02 SIGNIFICANCE OF F = SIGNIFICANT
R = +3.3267419E-01 SIGNIFICANCE OF R = SIGNIFICANT
t = +1.6718335E+01 SIGNIFICANCE OF t = SIGNIFICANT
N = 2248 DEGREES OF FREEDOM = 2246
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = CROSSLINK DENSITY
UNIT OF MEASURE = MILLIMOLE/CC *10^-1
-0.08
0.00
0.08
0.16
0.24
0.32
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
AGE AT TEST (YEARS)
STAGE 1 WING 142 TP-H1011 SOL GEL CROSSLINK DENSITY

Figure 42

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
62.0	4	91.0	72	116.0	40	141.0	28
63.0	8	92.0	103	117.0	12	142.0	52
66.0	4	93.0	108	118.0	32	143.0	39
67.0	8	94.0	130	119.0	16	144.0	12
68.0	12	95.0	84	120.0	28	145.0	12
70.0	4	96.0	59	121.0	20	146.0	12
71.0	4	97.0	19	122.0	56	147.0	4
72.0	3	98.0	24	123.0	40	148.0	4
74.0	36	99.0	12	124.0	28	149.0	27
75.0	8	100.0	16	125.0	48	154.0	24
76.0	16	101.0	32	126.0	27	155.0	16
77.0	20	102.0	16	127.0	44	160.0	30
78.0	36	103.0	8	128.0	24		
79.0	20	104.0	12	129.0	21		
80.0	36	105.0	12	130.0	8		
81.0	56	106.0	20	131.0	20		
82.0	40	107.0	32	132.0	16		
83.0	24	108.0	24	133.0	12		
84.0	24	109.0	32	134.0	4		
85.0	24	110.0	16	135.0	8		
86.0	32	111.0	24	136.0	36		
87.0	20	112.0	20	137.0	32		
88.0	4	113.0	20	138.0	19		
89.0	72	114.0	20	139.0	28		
90.0	68	115.0	16	140.0	40		

STAGE 1,WING 1&2,SOL GEL, % EXTRACTABLE,TPH-1011

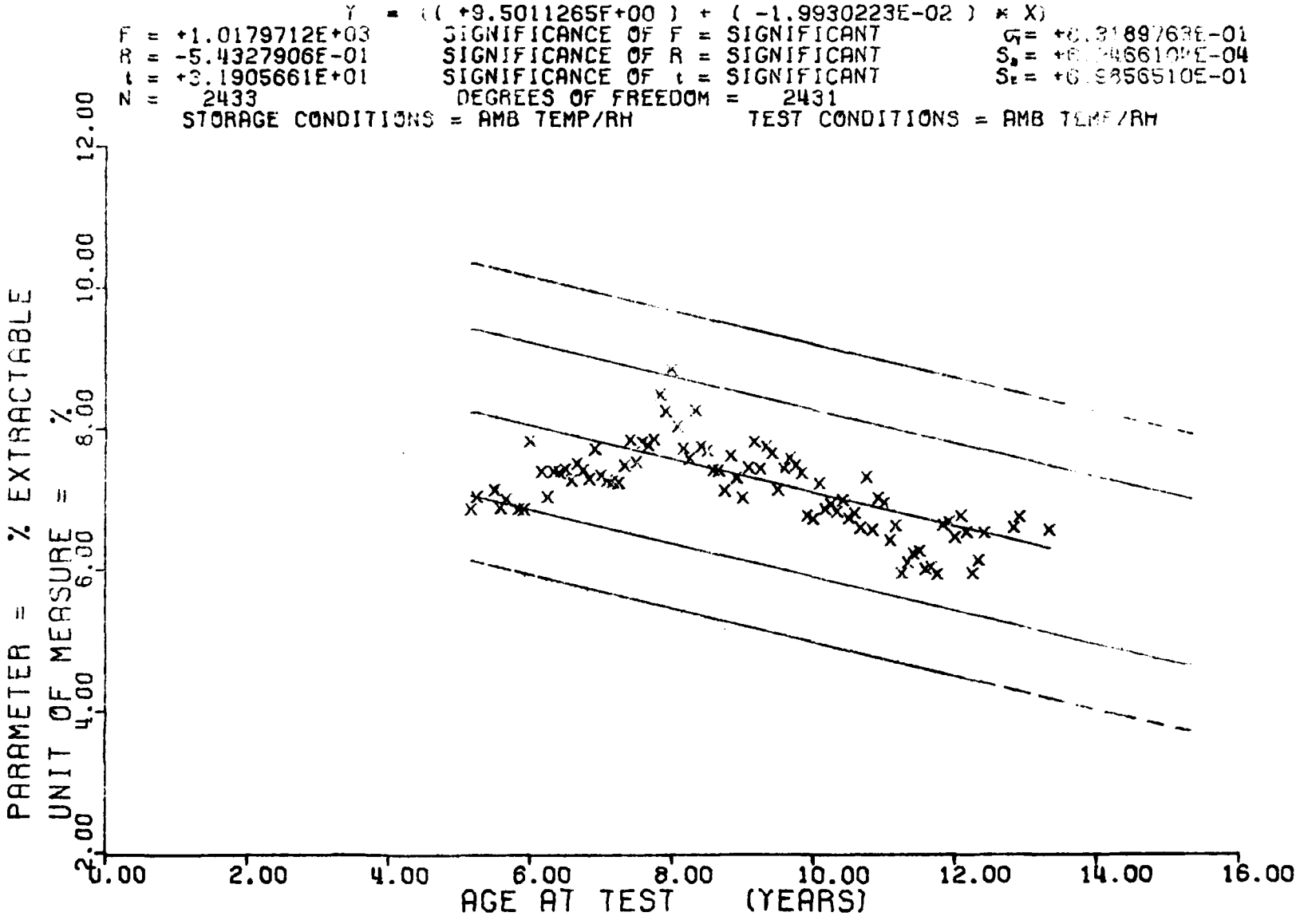
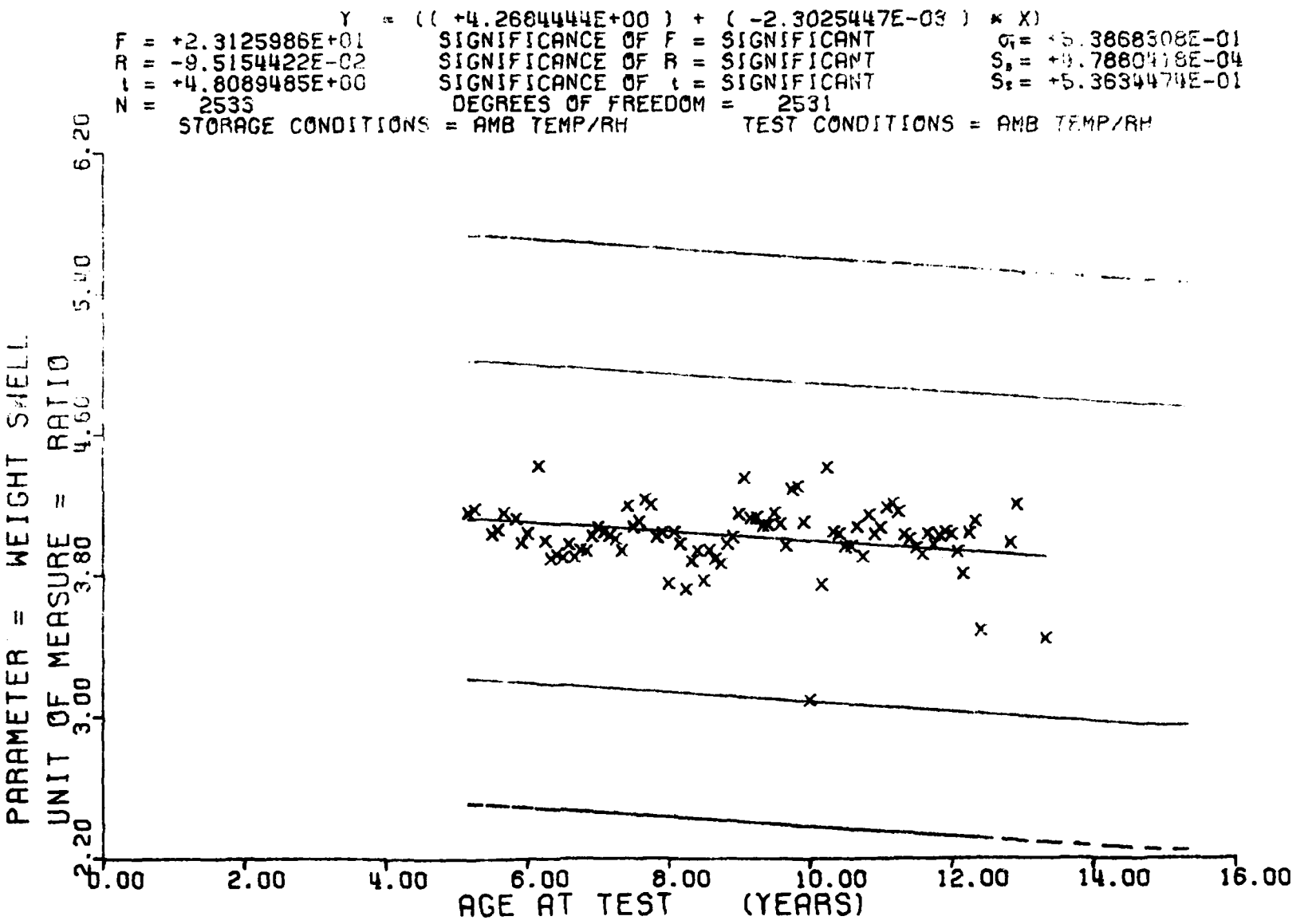

Y = ((+9.5011265E+00) + (-1.9930223E-02) * X)
F = +1.0179712E+03
R = -5.4327906E-01
t = +3.1905661E+01
N = 2433
SIGNIFICANCE OF F = SIGNIFICANT
SIGNIFICANCE OF R = SIGNIFICANT
SIGNIFICANCE OF t = SIGNIFICANT
DEGREES OF FREEDOM = 2431
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = AMB TEMP/RH
PARAMETER = % EXTRACTABLE
UNIT OF MEASURE = %
2.00
4.00
6.00
8.00
10.00
12.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
AGE AT TEST (YEARS)
STAGE 1,WING 1&2,SOL GEL, % EXTRACTABLE,TPH-1011

Figure 43

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
62.0	4	91.0	72	116.0	48	141.0	28
63.0	8	92.0	103	117.0	12	142.0	52
66.0	4	93.0	108	118.0	32	143.0	40
67.0	8	94.0	130	119.0	16	144.0	12
68.0	12	95.0	84	120.0	28	145.0	12
70.0	4	96.0	59	121.0	20	146.0	12
71.0	4	97.0	19	122.0	56	147.0	4
72.0	3	98.0	24	123.0	40	148.0	4
74.0	36	99.0	12	124.0	28	149.0	27
75.0	8	100.0	16	125.0	48	154.0	24
76.0	16	101.0	32	126.0	27	155.0	16
77.0	20	102.0	16	127.0	44	160.0	30
78.0	36	103.0	8	128.0	24		
79.0	20	104.0	12	129.0	21		
80.0	36	105.0	12	130.0	8		
81.0	56	106.0	20	131.0	20		
82.0	40	107.0	32	132.0	16		
83.0	24	108.0	24	133.0	12		
84.0	24	109.0	36	134.0	4		
85.0	24	110.0	28	135.0	8		
86.0	32	111.0	40	136.0	36		
87.0	20	112.0	32	137.0	32		
88.0	4	113.0	35	138.0	19		
89.0	72	114.0	40	139.0	28		
90.0	68	115.0	28	140.0	40		

STAGE 1, WING 1&2, TP-H1011, SOL GEL, WT. SWELL RATIO



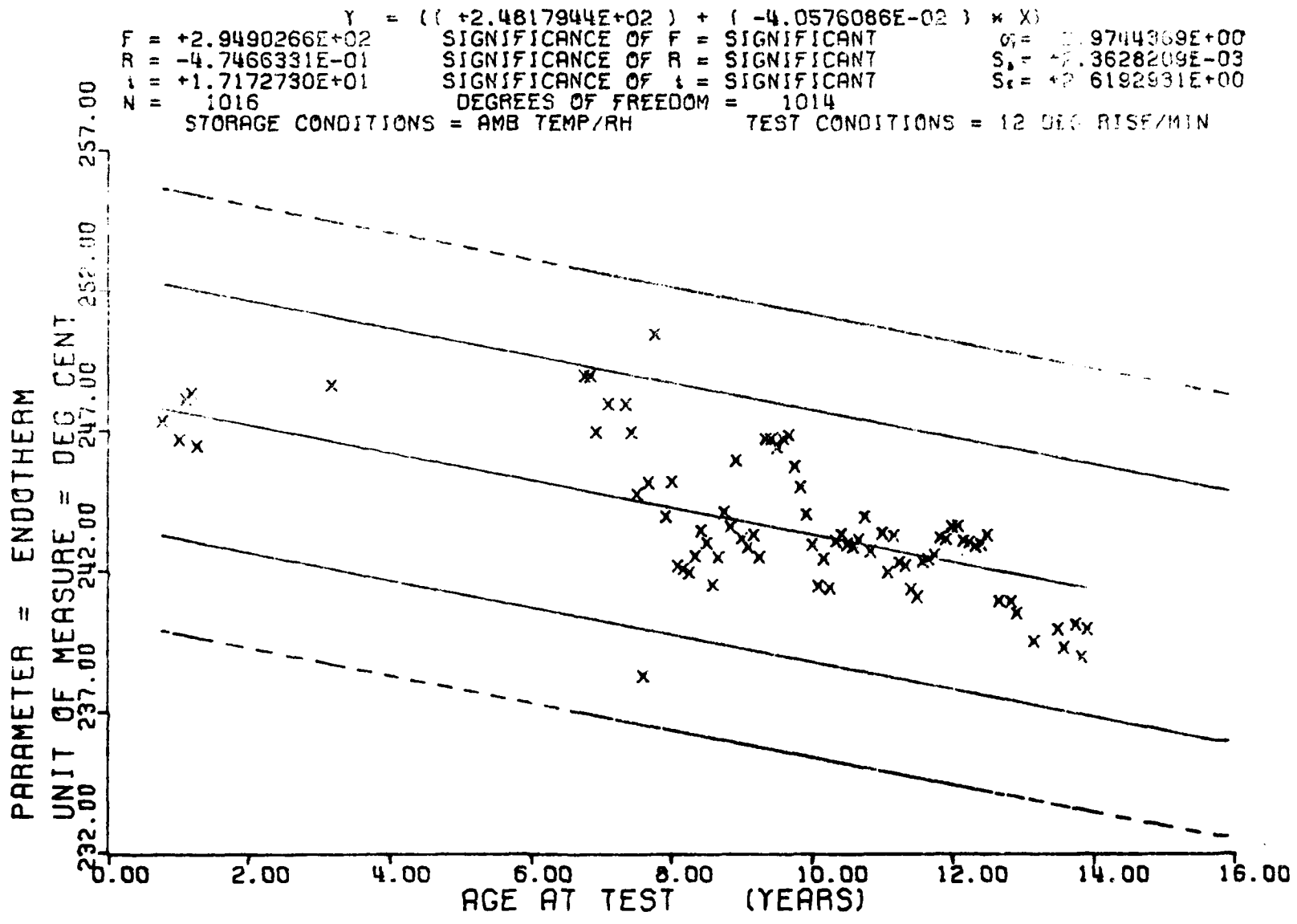
STAGE 1, WING 142, TP-H1011, 90L GEL, WT. SWELL RATIO

Figure 44

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
9.0	16	102.0	15	127.0	12	155.0	9
12.0	24	103.0	30	128.0	6	158.0	5
13.0	12	104.0	15	129.0	3	162.0	3
14.0	16	105.0	6	130.0	4	163.0	3
15.0	8	106.0	27	132.0	5	165.0	6
38.0	3	107.0	9	133.0	4	166.0	6
81.0	1	108.0	9	134.0	16	167.0	3
82.0	1	109.0	11	135.0	25		
83.0	1	110.0	23	136.0	25		
84.0	1	111.0	11	137.0	29		
85.0	2	112.0	17	138.0	43		
87.0	1	113.0	34	139.0	38		
88.0	1	114.0	11	140.0	21		
89.0	1	115.0	19	141.0	8		
90.0	5	116.0	18	142.0	8		
91.0	6	117.0	14	143.0	22		
92.0	5	118.0	17	144.0	11		
93.0	4	119.0	24	145.0	12		
95.0	4	120.0	18	146.0	21		
96.0	12	121.0	21	147.0	12		
97.0	16	122.0	6	148.0	17		
98.0	21	123.0	9	149.0	3		
99.0	9	124.0	17	150.0	6		
100.0	17	125.0	11	152.0	6		
101.0	14	126.0	3	154.0	24		

STAGE 1,WING 152,DTA,12 DEG C RISE/MIN, ENDOTHERM



STAGE 1,WING 142,DTA,12 DEG C RISE/MIN, ENDOTHERM

Figure 45

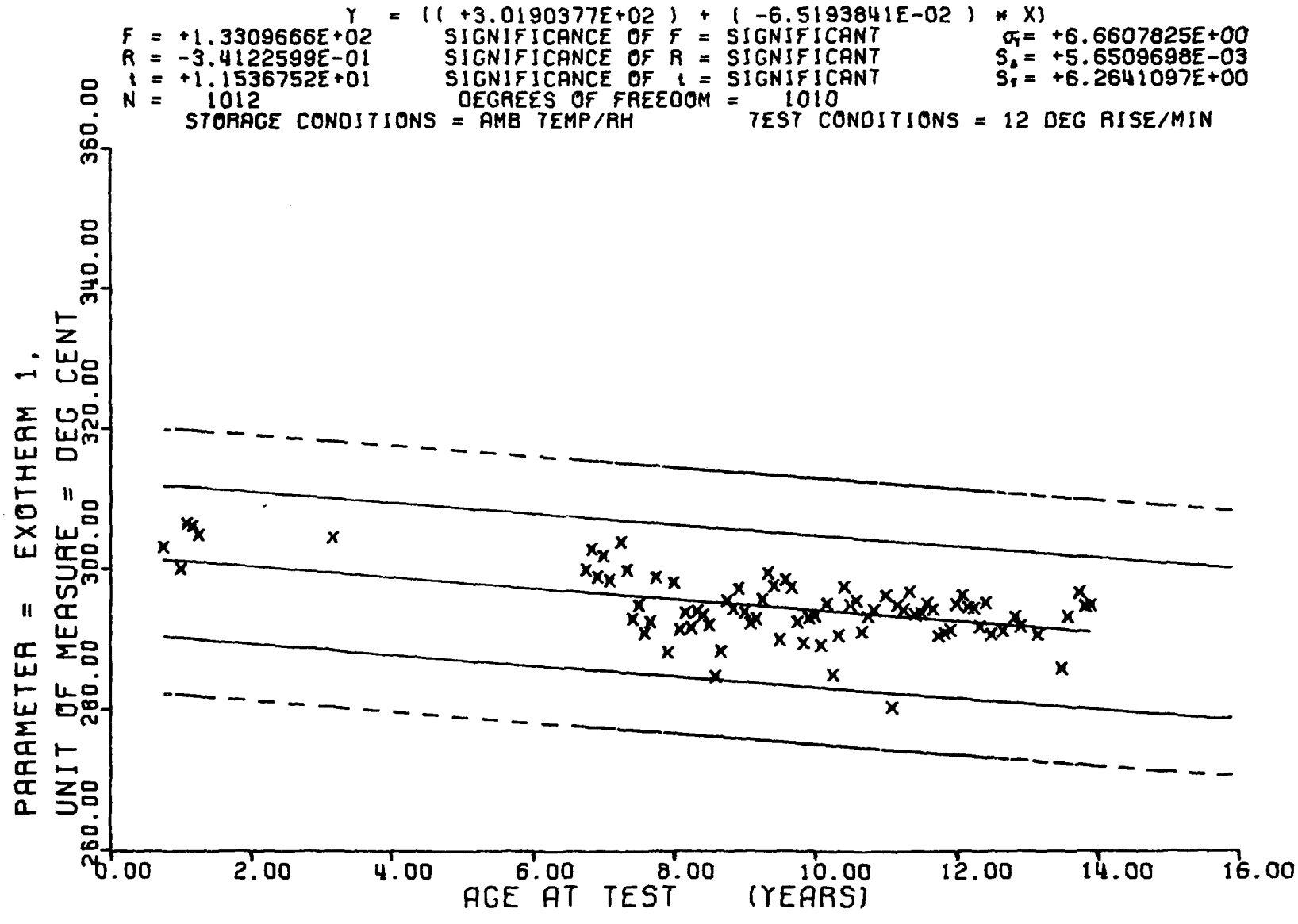
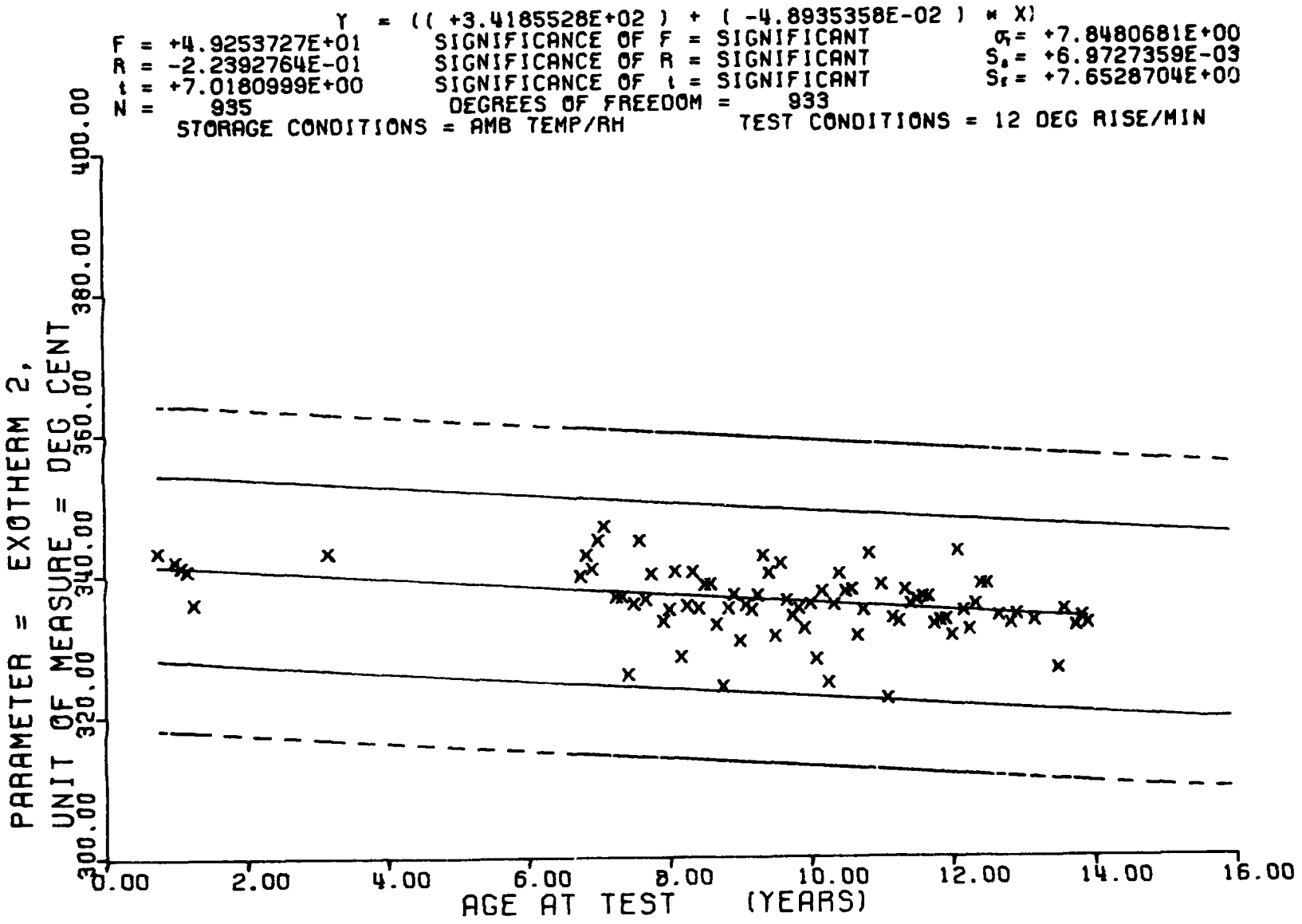

Y = ((+3.0190377E+02) + (-6.5193841E-02) * X)
F = +1.3309666E+02 SIGNIFICANCE OF F = SIGNIFICANT σ = +6.6607825E+00
R = -3.4122599E-01 SIGNIFICANCE OF R = SIGNIFICANT S = +5.6509698E-03
t = +1.1536752E+01 SIGNIFICANCE OF t = SIGNIFICANT S = +6.2641097E+00
N = 1012 DEGREES OF FREEDOM = 1010
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = 12 DEG RISE/MIN
PARAMETER = EXOTHERM 1,
UNIT OF MEASURE = DEG CENT
360.00
340.00
320.00
300.00
280.00
260.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
AGE AT TEST (YEARS)
STAGE 1,WING 142,DTA,12 DEG C RISE/MIN, EXOTHERM #1

Figure 46

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
9.0	16	102.0	14	127.0	12	153.0	9
12.0	24	103.0	27	128.0	6	158.0	9
13.0	12	104.0	10	129.0	3	161.0	3
14.0	14	105.0	6	130.0	4	163.0	3
15.0	8	106.0	23	132.0	5	165.0	6
30.0	3	107.0	8	133.0	4	169.0	6
71.0	1	108.0	9	134.0	16	182.0	3
72.0	1	109.0	8	135.0	23		
83.0	1	110.0	18	136.0	25		
84.0	1	111.0	11	137.0	20		
85.0	2	112.0	15	138.0	43		
87.0	1	113.0	34	139.0	37		
88.0	1	114.0	10	140.0	20		
89.0	1	115.0	19	141.0	8		
90.0	4	116.0	18	142.0	8		
91.0	2	117.0	13	143.0	20		
92.0	5	118.0	13	144.0	11		
93.0	4	119.0	22	145.0	12		
95.0	4	120.0	18	146.0	21		
96.0	6	121.0	20	147.0	12		
97.0	10	122.0	6	148.0	17		
98.0	14	123.0	8	149.0	3		
99.0	6	124.0	16	150.0	8		
100.0	12	125.0	11	152.0	6		
101.0	13	126.0	3	154.0	20		

STAGE 1,WING 182,DTA,12 DEG C RISE/MIN, EXCTHERM 42



STAGE 1,WING 142,OTA,12 DEG C RISE/MIN, EXOTHERM =2

Figure 47

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
85.0	1	120.0	7	163.0	1
90.0	1	121.0	2		
92.0	2	123.0	3		
95.0	3	124.0	10		
96.0	2	125.0	1		
97.0	3	127.0	5		
98.0	3	128.0	6		
99.0	5	135.0	11		
100.0	2	136.0	9		
101.0	7	137.0	12		
103.0	9	138.0	19		
104.0	5	139.0	19		
106.0	5	140.0	10		
107.0	4	141.0	6		
109.0	7	142.0	8		
110.0	13	143.0	9		
111.0	5	144.0	8		
112.0	7	145.0	8		
113.0	11	146.0	6		
114.0	4	147.0	2		
115.0	5	148.0	8		
116.0	2	150.0	5		
117.0	5	152.0	2		
118.0	11	154.0	1		
119.0	10	158.0	5		

STAGE 1,WING 152,DTA,12 DEG C RISE/MIN, EXOTHERM #3

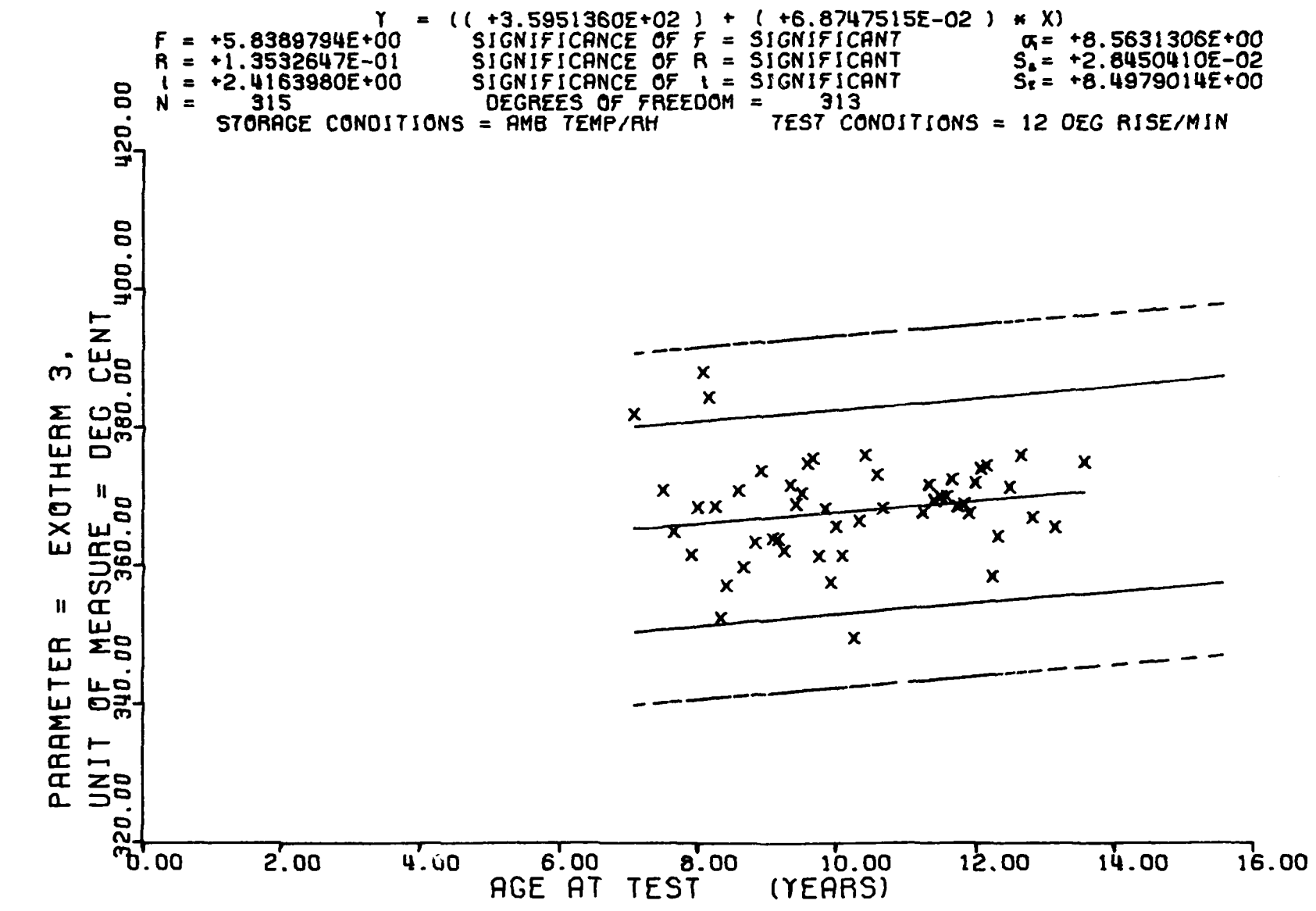
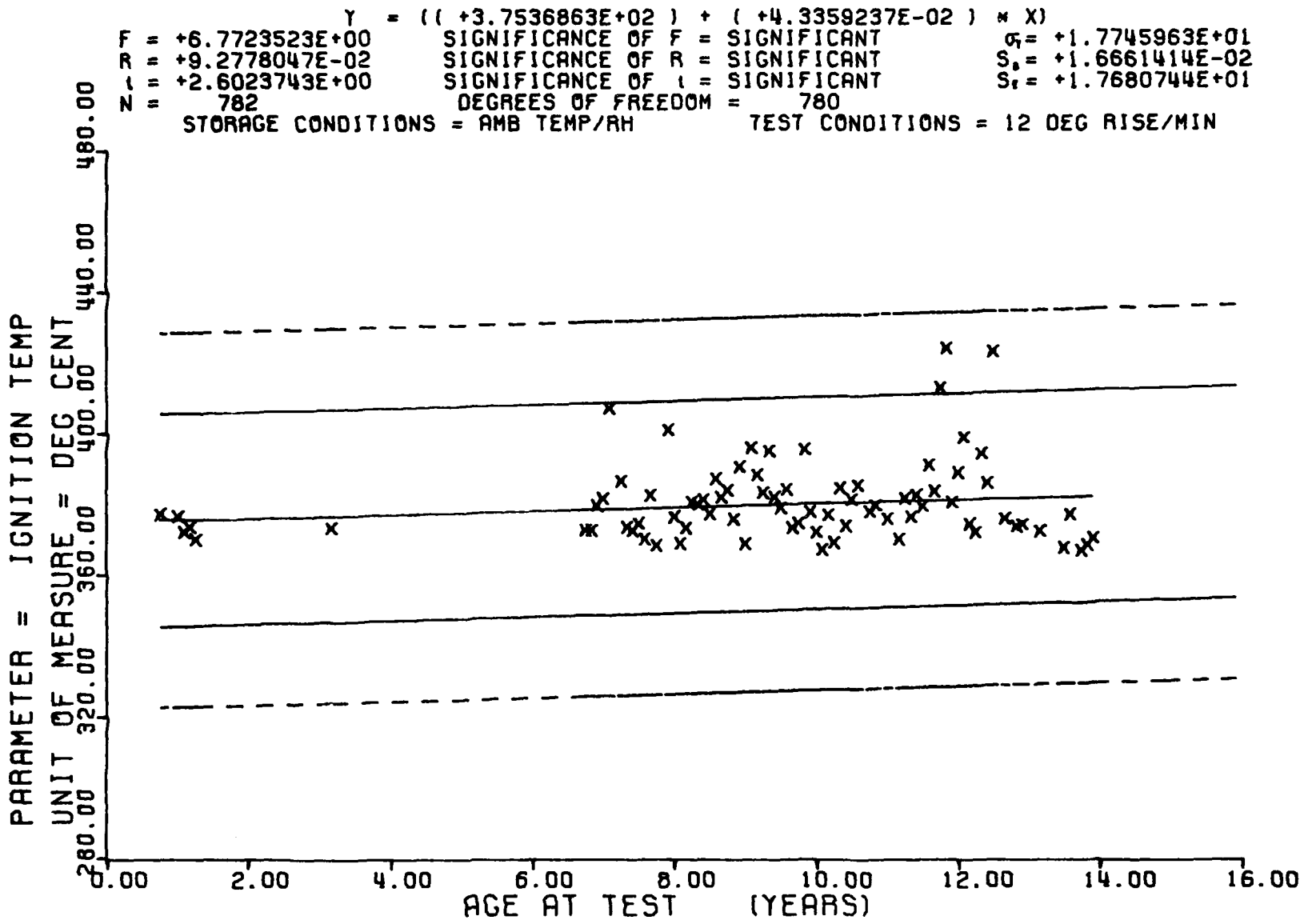

Y = ((+3.5951360E+02) + (+6.8747515E-02) * X)
F = +5.8389794E+00 SIGNIFICANCE OF F = SIGNIFICANT σ = +8.5631306E+00
R = +1.3532647E-01 SIGNIFICANCE OF R = SIGNIFICANT S_a = +2.8450410E-02
t = +2.4163980E+00 SIGNIFICANCE OF t = SIGNIFICANT S_r = +8.4979014E+00
N = 315 DEGREES OF FREEDOM = 313
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = 12 DEG RISE/MIN
PARAMETER = EXOTHERM 3,
UNIT OF MEASURE = DEG CENT
320.00
340.00
360.00
380.00
400.00
420.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
AGE AT TEST (YEARS)
STAGE 1,WING 142,DTA,12 DEG C RISE/MIN, EXOTHERM =3

Figure 48

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
9.0	16	102.0	15	127.0	6	162.0	3
12.0	24	103.0	27	129.0	3	163.0	2
13.0	12	104.0	14	130.0	2	165.0	6
14.0	16	105.0	6	132.0	5	166.0	6
15.0	8	106.0	23	134.0	14	167.0	3
80.0	3	107.0	9	135.0	16		
81.0	1	108.0	9	136.0	15		
82.0	1	109.0	7	137.0	19		
83.0	1	110.0	15	138.0	27		
84.0	1	111.0	7	139.0	25		
85.0	2	112.0	14	140.0	11		
87.0	1	113.0	23	141.0	6		
88.0	1	114.0	8	142.0	2		
89.0	1	115.0	17	143.0	15		
90.0	5	116.0	16	144.0	6		
91.0	5	117.0	10	145.0	6		
92.0	4	118.0	11	146.0	14		
93.0	4	119.0	18	147.0	9		
95.0	2	120.0	11	148.0	17		
96.0	12	121.0	20	149.0	3		
97.0	13	122.0	3	150.0	4		
99.0	20	123.0	7	152.0	4		
99.0	6	124.0	9	154.0	24		
100.0	15	125.0	10	155.0	9		
101.0	8	126.0	3	158.0	4		

STAGE 1,WING 152,DTA,12 DEG C RISE/MIN, IGNITION



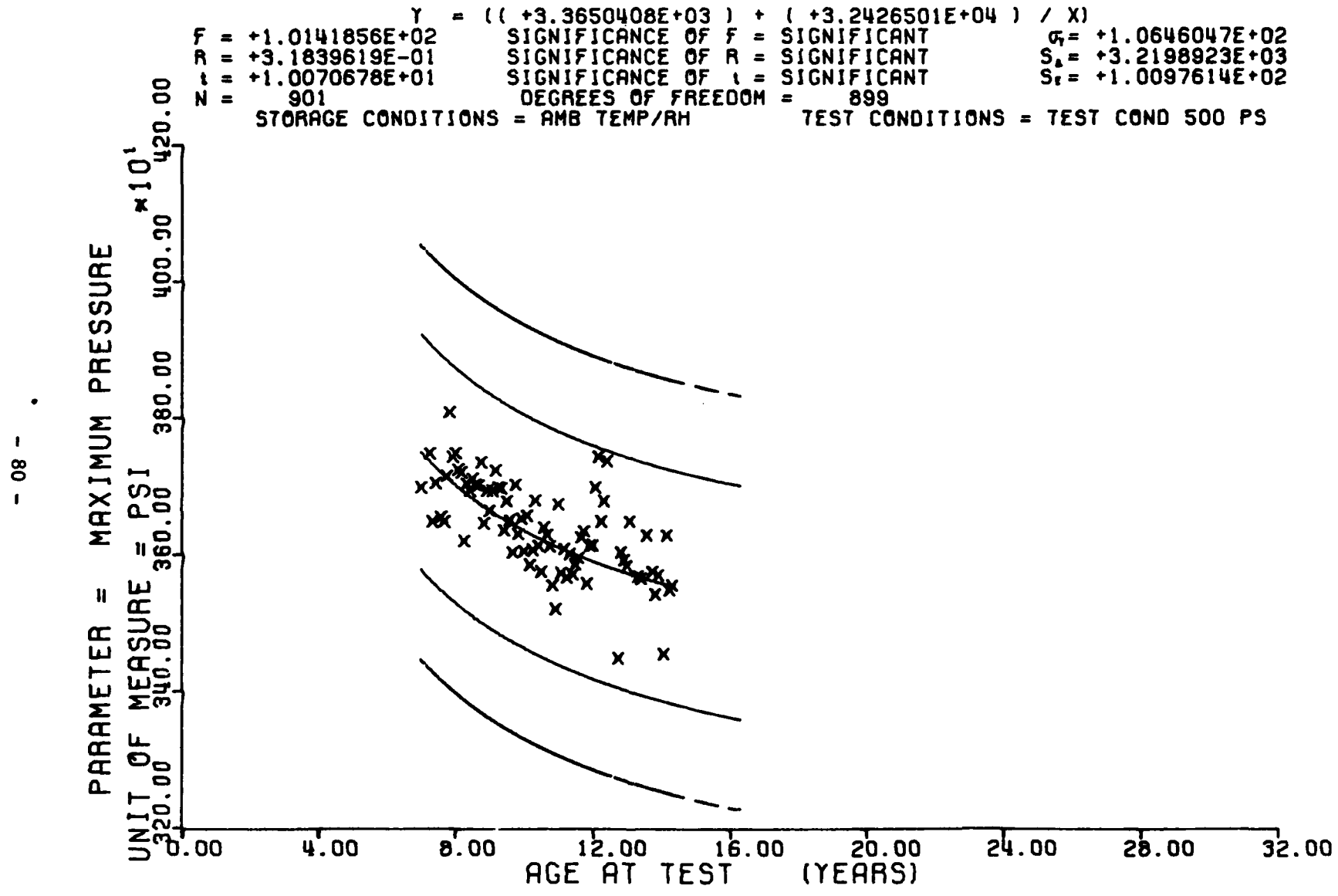
STAGE 1,WING 142,DTA,12 DEG C RISE/MIN, IGNITION

Figure 49

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
12.0	10	114.0	12	139.0	11
88.0	1	115.0	6	140.0	4
91.0	2	116.0	10	141.0	5
92.0	4	117.0	6	142.0	5
93.0	1	118.0	6	143.0	7
94.0	3	119.0	12	144.0	5
95.0	3	120.0	8	145.0	2
96.0	2	121.0	8	146.0	3
97.0	4	122.0	9	148.0	2
98.0	4	123.0	12	159.0	1
99.0	10	124.0	6	161.0	1
100.0	7	125.0	11	162.0	1
101.0	10	126.0	9	163.0	1
102.0	8	127.0	11	165.0	2
103.0	9	128.0	8	166.0	2
104.0	9	129.0	4	168.0	1
105.0	6	130.0	6	169.0	1
106.0	10	131.0	7	171.0	2
107.0	7	132.0	5		
108.0	12	133.0	9		
109.0	6	134.0	11		
110.0	8	135.0	8		
111.0	8	136.0	8		
112.0	12	137.0	8		
113.0	7	138.0	15		

STAGE 1 WING 162 TP-H1011 IGNITABILITY, IGN THRESHOLD POINT, 168 CAL/SQ CM/SEC



STAGE 1,WING 1&2,PRESSURE TIME,MAXIMUM PRESSURE

Figure 50

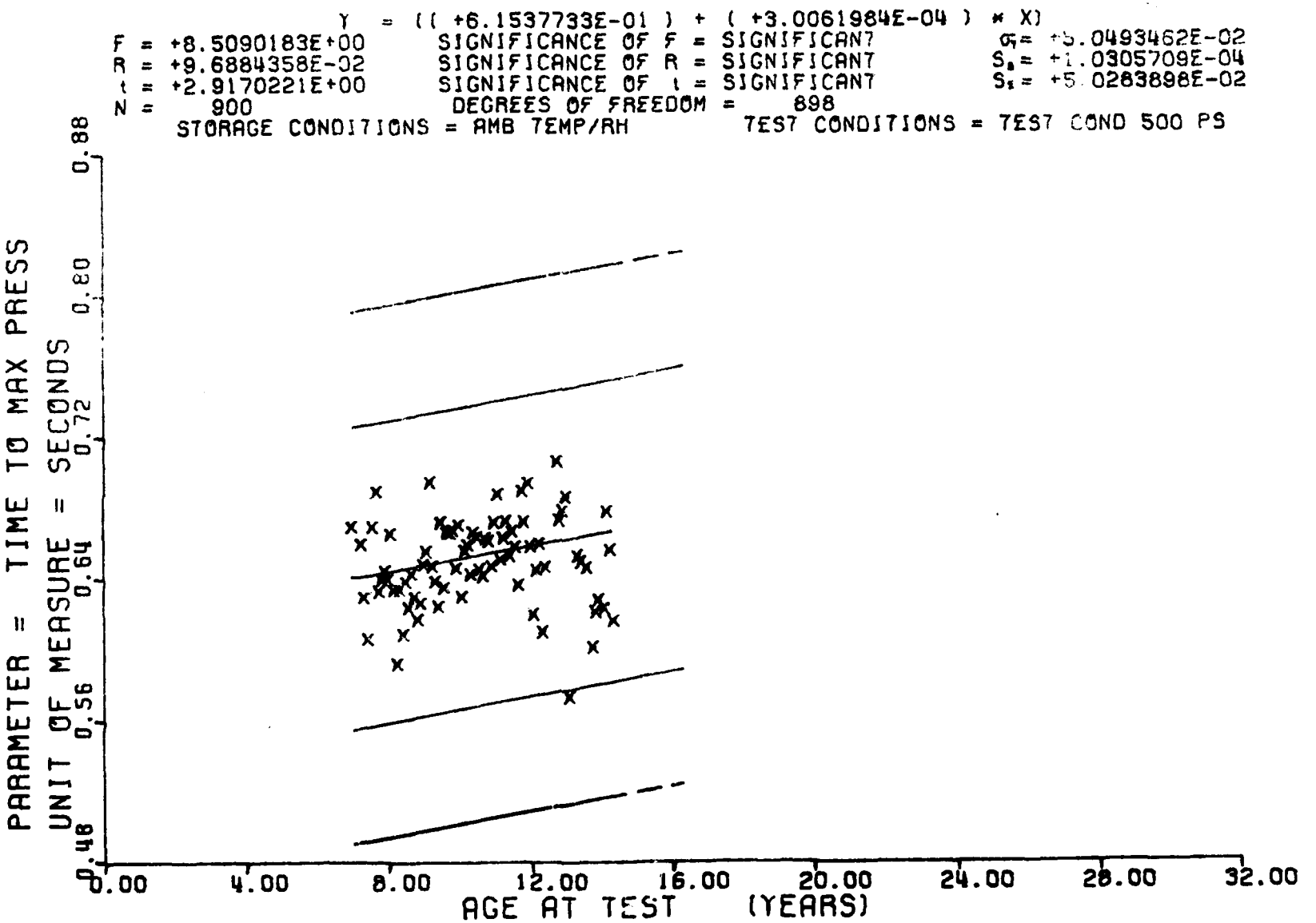
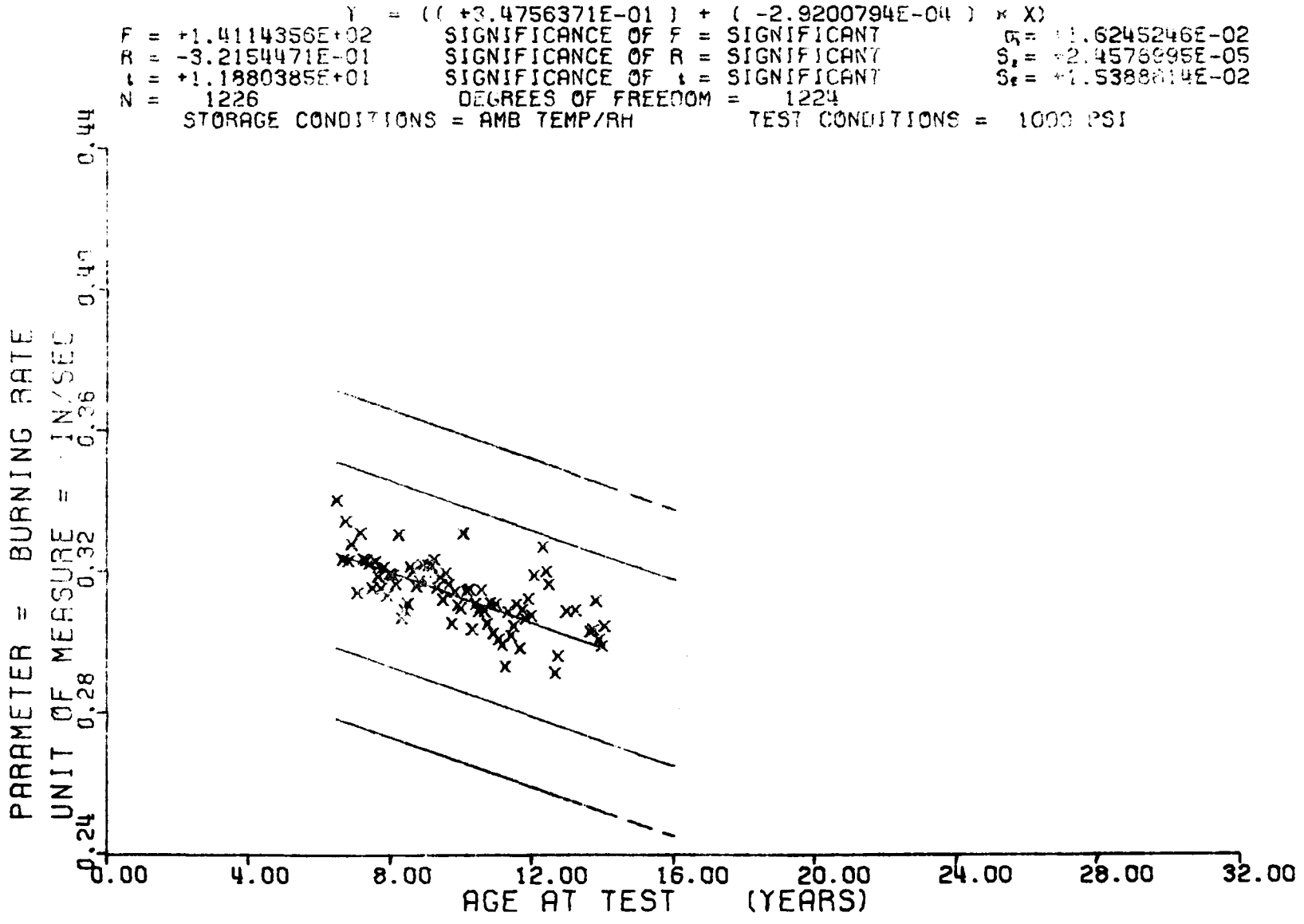

Y = ((+6.1537733E-01) + (+3.0061984E-04) * X)
F = +8.5090183E+00 SIGNIFICANCE OF F = SIGNIFICANT
R = +9.6884358E-02 SIGNIFICANCE OF R = SIGNIFICANT
t = +2.9170221E+00 SIGNIFICANCE OF t = SIGNIFICANT
N = 900 DEGREES OF FREEDOM = 898
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = TEST COND 500 PS
PARAMETER = TIME TO MAX PRESS
UNIT OF MEASURE = SECONDS
0.88
0.80
0.72
0.64
0.56
0.48
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1,WING 142,PRESSURE TIME,TIME TO MAXIMUM PRESSURE

Figure 51

*** SAMPLE SIZE SUMMARY ***

AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES	AGE MONTHS	NR SAMPLES
78.0	3	105.0	21	130.0	24	165.0	6
80.0	8	106.0	18	131.0	21	166.0	3
81.0	3	107.0	21	132.0	12	167.0	3
82.0	3	108.0	18	133.0	26	168.0	6
83.0	9	109.0	15	134.0	36	169.0	6
85.0	3	110.0	9	135.0	9		
86.0	3	111.0	24	136.0	51		
87.0	9	112.0	27	137.0	45		
88.0	12	113.0	21	138.0	33		
89.0	6	114.0	21	139.0	48		
90.0	3	115.0	18	140.0	18		
91.0	14	116.0	18	141.0	18		
92.0	15	117.0	45	142.0	9		
93.0	3	118.0	21	143.0	9		
94.0	3	119.0	18	144.0	9		
95.0	12	120.0	24	145.0	6		
96.0	9	121.0	18	146.0	3		
97.0	3	122.0	18	148.0	9		
98.0	9	123.0	26	149.0	3		
99.0	6	124.0	21	150.0	3		
100.0	6	125.0	24	152.0	6		
101.0	15	126.0	35	153.0	15		
102.0	18	127.0	23	156.0	3		
103.0	18	128.0	36	159.0	6		
104.0	15	129.0	29	164.0	3		

STAGE 1, WING A-B, TP/H1011, BURNING RATE 1000 PSI



STAGE 1, WING A&B, TP-H1011, BURNING RATE 1000 PSI

Figure 52

DISTRIBUTION

	NR COPIES
OOALC	
MMWRME	1
MMWRMT	1
DDC (TISIR) Cameron Station, Alexandria, VA 22314	2
SAMSO, Norton AFB, CA 92409 MNNP	1
TWR Systems, Norton AFB, CA 92409 Attn: Mr. J. C. Metcalf, Bldg. 523/315	1
AFPRO, Thiokol Chemical Corporation Wasatch Division P. O. Box 524 Brigham City, UT 84302 (Cy to R. E. Keating)	2
AFRPL (MKPB) Edwards AFB, CA 93523	1
SAC (LGMB) Offutt AFB, NB 68113	1
U. S. Naval Ordnance Station, Indian Head, MD 20640 Attn: Dr. James H. Wiegand Fleet Support Dept., Propulsion System Development Division, Code FS7	1
CPIA, Johns Hopkins University Attn: Dr. P. L. Nichols Applied Physics Laboratory Johns Hopkins Road Laurel, MD 20810	1
Naval Plant Branch Representative Attn Mr. David W. Pratt P. O. Box 157, Bacchus Works Magna, UT 84044	1

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: 388(78) (4) MMEMP 388(78) — 2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): Propellant Surveillance Report (0) LGM-30 A & B Stage I, TP-H1011,	5. TYPE OF REPORT & PERIOD COVERED: (1) Test REsults-Semi Annual rept. (2)
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): John A. Thompson	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Propellant Lab Section, Directorate of Maintenance, OO-ALC Hill AFB, Utah 84406	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: MMWRM Project M82934C-WNL-17514
11. CONTROLLING OFFICE NAME AND ADDRESS: Service Engineering Division, Directorate of Material Management, OO-ALC Hill AFB, Utah 84406	12. REPORT DATE: Jan 1978
	13. NUMBER OF PAGES: 114
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release, Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Solid Propellant
Minuteman

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report contains propellant test results from cartons of TP-H1011 bulk propellant representing LGM-30 A and B First Stage Minuteman Motors. This report is the thirteenth time that a statistical approach has been used to analyze First Stage bulk carton propellant. Testing was accomplished in accordance with MMEMP Project M82934C-WNL17514.

The purpose of testing was to determine and provide early warning of any serious degradation trends occurring in the propellant for service life predictions.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE - 85 -

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

7387

TC

20 (cont't)

An analysis of all parameters indicates that no potential problems are expected in the propellant for at least two years past the oldest data point.

Data stored in the G085 System were plotted utilizing the IBM 360-65 Computer and CAL-COMP Plotter. The data range at any age can be found by suitable inquiry of the G085 System.

Each point on the regression plot represents the mean of all samples at that particular age. The number of specimens at each point is indicated on the sample size summary sheet accompanying each regression plot or group of regression plots.